FINAL HUMAN HEALTH RISK ASSESSMENT
SYOSSET LANDFILL SITE
SYOSSET, NEW YORK

Prepared for
U.S. ENVIRONMENTAL PROTECTION AGENCY
290 Broadway
New York, New York 10007-1866

EPA Work Assignment No.	:	074-2P39
EPA Region	:	II
Contract No.	:	68-W9-0024
Document Control No.	:	7720-074-RA-CJRZ
Prepared by	:	CDM Federal Programs Corporation
Work Assignment Project Manager	:	Sally Odland
Telephone Number	:	(212) 393-9634
EPA Work Assignment Manager	:	Sherrel Henry
Telephone Number	:	(212) 637-4273
Date Prepared	:	January 25, 1996

370949

CDM FEDERAL PROGRAMS CORPORATION

January 25, 1996

Ms. Alison Devine
Project Officer
U.S. Environmental Protection Agency
290 Broadway - 18th Floor - E34
New York, NY 10007-1866

PROJECT: ARCS II, Contract No.: 68-W9-0024
Work Assignment No.: 074-2P39

DOCUMENT CONTROL NO.: 7720-074-EP-CJSB

SUBJECT: Final Risk Assessment
Syosset Landfill Assessment
Syosset, New York

Dear Ms. Devine:

Enclosed please find a copy of the final Risk Assessment for the Syosset Landfill OU2 site in partial fulfillment of the requirements of the project. CDM FEDERAL PROGRAMS CORPORATION has incorporated EPA's comments and has completed this risk assessment under an expedited completion schedule as requested by the EPA Work Assignment Manager, Ms. Sherrel Henry. Final resolution of comments was made on January 22, 1996. Please contact me with any questions or comments.

Very truly yours,
CDM FEDERAL PROGRAMS CORPORATION

Robert D. Goltz, P.E.
ARCS II Program Manager

cc: S. Henry, EPA WAM
M. Olsen, EPA Risk Specialist
S. Odland, CDM Federal WAM
P. Hastings, ARCS II OM (letter only)
S. Insetta, CDM Federal, PHL
J. Naugle, CDM Federal, NWJY
Document Control

CDM FEDERAL PROGRAMS CORPORATION

January 25, 1996

Ms. Sherrel Henry
Work Assignment Manager
U.S. Environmental Protection Agency
20th Floor, Room W41
290 Broadway
New York, NY 10007

PROJECT: ARCS II, Contract No.: 68-W9-0024
Work Assignment No.: 074-2P39

DOCUMENT CONTROL NO.: 7720-074-RA-CJRZ

SUBJECT: Final Risk Assessment
Syosset Landfill OU2 Site
Syosset, New York

Dear Ms. Henry:

CDM FEDERAL PROGRAMS CORPORATION (CDM Federal) is pleased to submit this final Risk Assessment (RA) for the Syosset Landfill OU2 site in Syosset, New York. This submittal satisfies the second reporting requirement of Task 4.3.

This final RA reflects a modification of the draft RA (submitted on August 4, 1995) in response to EPA comments received on September 20, 1995 and reflects EPA direction of January 22, 1996 to qualitatively include Round 3 sampling data in the risk assessment. The following is a summary of the comments (paraphrased for brevity) made to the draft RA and the response taken.

Draft RA Page No.	Specific Comment	Action
List of Abbreviations	Add "(i.e., the Superfund Program)" after CERCLA definition.	Accepted

Draft RA Page No.	Specific Comment	Action
ii	Indicate the date the ROD was signed and that remedial activities are underway.	Accepted
iii	Add a paragraph describing the groundwater future use scenario.	Accepted
1	Augument the determination not to access current exposure.	Accepted
2	Figure 1 should be Figure 1-1.	Accepted
4	A reference to the ERM report should be provided.	Not provided, as per discussion between S. Henry, EPA and S. Boone, CDM Federal on 9/26/95
5	Add reference to the OU1 ROD.	Accepted
8	Add reference to the use of a 95% UCL.	Accepted
18	Add reference to USEPA 1989b.	Accepted
21	Add reference to Carcinogen Risk Assessment Guidelines.	Accepted
22	Add reference to USEPA 1989b. Add missing words to sentence concerning semivolatiles and pesticide/PCBs.	Accepted

Draft RA

Page No.	Specific Comment	Action
38, 39 (Tables 3-2 and 3-3)	Indicate that different averaging times are used for carcinogens and noncarcinogens.	Accepted
41	Move parenthesis before "USEPA" so it reads as a reference.	Accepted
46	Indicate that a Reference Concentration is converted to develop inhalation reference doses.	Accepted
49	The Uncertainty Factors and Modifying Factors should be explained.	Accepted
62	Add reference to USEPA 1989b.	Accepted
67	Indicate low probability of current use of the shallow upper aquifer.	Accepted
71	Capitalize system in reference to the Integrated Risk Information System. Include citation for Casarett and Doull's 4th Edition.	Accepted
72	Expand reference to Nassau County to include the Department of Health. Remove the second period in the Olsen reference.	Accepted
74	Include supplements to Health Effects Assessment Summary Tables in reference.	Accepted

This submittal is comprised of a single volume, divided into seven chapters/sections and supplemented with five appendices. Please contact me with questions or comments regarding this submittal at 212/393-9634.

Very truly yours,

CDM FEDERAL PROGRAMS CORPORATION

Sally Odland
Work Assignment Manager

SYOSSET/finalra.ltr/January 25, 1996/day

TABLE OF CONTENTS

Section — Page

EXECUTIVE SUMMARY
BASELINE HUMAN HEALTH RISK ASSESSMENT i

1.0 INTRODUCTION 1

1.1 Overview 1

1.2 Site Description 2

1.3 Scope of the Risk Assessment 6

1.4 Organization of the Risk Assessment 7

2.0 DATA COLLECTION AND EVALUATION 12

2.1 Summary of Groundwater Sampling and Analysis Activities 14

2.2 Summary of Sampling and Analysis Results 16

2.2.1 Data Quality 16

2.2.2 Chemicals Detected in Groundwater 16

2.3 Criteria for the Selection of Chemicals of Potential Concern 18

2.3.1 Blank Concentrations 23

2.3.2 Background Concentrations 24

2.3.3 Physical and Chemical Properties 25

2.4 Evaluation of Tentatively Identified Compounds (TICs) 27

2.5 Selected Chemicals of Potential Concern 28

TABLE OF CONTENTS (Cont'd)

Page

3.0 EXPOSURE ASSESSMENT 30

3.1 Potential Release and Transport Mechanisms 30

3.2 Identification of Exposure Pathways 31

3.2.1 Present-Use Scenarios 32

3.2.2 Future-Use Scenarios 33

3.3 Exposure Point Concentrations 33

3.3.1 Exposure Point Concentration Modeling 36

3.4 Calculation of Chronic Daily Intakes 38

3.5 Groundwater Exposure Assumptions 39

4.0 TOXICITY ASSESSMENT 44

4.1 Health Effects Criteria for Carcinogens 45

4.2 Health Effects Criteria for Noncarcinogens 48

4.3 Qualitative Discussion of Chemicals Not Quantitatively Evaluated in the Risk Assessment 51

5.0 RISK CHARACTERIZATION 54

5.1 Carcinogenic Risk Characterization 54

5.2 Noncarcinogenic Effects Characterization 55

5.3 Quantitative Results of Carcinogenic Risk and Noncarcinogenic Effects Evaluation for Groundwater 56

TABLE OF CONTENTS (Cont'd)

Page

5.4 Combining Cancer Risks and Noncancer Hazard Index Values Across Exposure Pathways 57

5.5 Applicable or Relevant and Appropriate Requirements (ARARs) . . . 58

6.0 UNCERTAINTIES IN RISK ASSESSMENT 63

6.1 Environmental Data 63

6.2 Exposure Pathway Assumptions 65

6.3 Toxicological Data 65

6.4 Risk Characterization 66

6.5 Central Tendency Calculations for Groundwater 66

7.0 SUMMARY OF THE BASELINE RISK ASSESSMENT 70

Baseline Risk Assessment Appendices

APPENDIX A: 95 Percent Upper Confidence Limit Calculations

APPENDIX B: Toxicological Profiles

APPENDIX C: Spreadsheet Calculations

APPENDIX D: Central Tendency Calculations

APPENDIX E: Site Data

APPENDIX F: Round 3 Site Data

LIST OF TABLES

Table 2-1	Summary of Chemicals in Groundwater
Table 2-2	Chemical Concentration - Toxicity Screen for Groundwater
Table 2-3	Summary of Chemicals of Potential Concern in Groundwater
Table 3-1	Potential Exposure Pathways
Table 3-2	Ingestion of Chemicals in Drinking Water
Table 3-3	Inhalation of Airborne Chemicals (Shower Scenario)
Table 3-4	Variables Used for Chronic Daily Intake Calculations
Table 4-1	Toxicity Values for Potential Carcinogenic Health Effects - Dose-Response Relationship
Table 4-2	Chronic Toxicity Values for Potential Noncarcinogenic Health Effects - Dose-Response Relationship
Table 5-1	Combining Carcinogenic Risks Across Pathways
Table 5-2	Combining Noncarcinogenic Hazard Index Values Across Pathways
Table 5-3	Detected Concentrations Versus Maximum Contaminant Levels (MCLs) for Chemicals of Potential Concern in Groundwater
Table 6-1	Variables Used for the Chronic Daily Intake Calculation for Central Tendency Evaluation

LIST OF FIGURES

Figure

1-1 Site Location Map, Syosset Landfill, Syosset, New York

2-1 Location of Groundwater Monitoring, Gas Monitoring Wells, Soil Borings, and Lines of Hydrogeologic Cross Section, Syosset Landfill, Syosset, New York

LIST OF ABBREVIATIONS

ARARs	-	Applicable or Relevant and Appropriate Requirements
ARCS	-	Alternative Remedial Contracting Strategy
AT	-	Averaging Time
BW	-	Body Weight
CA	-	Chemical Concentration in Air
CDI	-	Chronic Daily Intake
CDM Federal	-	CDM Federal Programs Corporation
CERCLA	-	Comprehensive Environmental Response, Compensation, and Liability Act (i.e. the Superfund Program)
CF	-	Conversion Factor
CLP	-	Contract Laboratory Program
CRAVE	-	Carcinogen Risk Assessment Verification Endeavor
CW	-	Chemical Concentration in Water
ED	-	Exposure Duration
EF	-	Exposure Frequency
ERM	-	Environmental Resources Management - Northeast
ET	-	Exposure Time
Geraghty & Miller	-	Geraghty & Miller, Inc.
HEAST	-	Health Effects Assessment Summary Tables
IR	-	Ingestion Rate; Inhalation Rate
IRIS	-	Integrated Risk Information System
K_{oc}	-	Organic Carbon Partition Coefficient
K_{ow}	-	Octanol-Water Partition Coefficient
LOAEL	-	Lowest-Observed-Adverse-Effect-Level
MCL	-	Maximum Contaminant Level
MF	-	Modifying Factor
NCP	-	National Oil and Hazardous Substances Pollution Contingency Plan
NCDOH	-	Nassau County Department of Health
NOAEL	-	No-Observed-Adverse-Effect-Level
NPL	-	Superfund National Priorities List
NYSDEC	-	New York State Department of Environmental Conservation
OU	-	Operable Unit
PC	-	Chemical-Specific Dermal Permeability Constant
PCBs	-	Polychlorinated Biphenyls
PRG	-	Preliminary Remediation Goal
PRP	-	Potentially Responsible Party
RAGS-HHEM	-	Risk Assessment Guidance for Superfund - Human Health Evaluation Manual
RAS	-	Routine Analytical Services

LIST OF ABBREVIATIONS (Cont'd)

RBC	-	Risk-Based Concentration
RfC	-	Reference Concentration
RfD	-	Reference Dose
RME	-	Reasonable Maximum Exposure
RI	-	Remedial Investigation
RI/FS	-	Remedial Investigation/Feasibility Study
ROD	-	Record of Decision
RPM	-	Remedial Project Manager
SA	-	Skin Surface Area
SF	-	Slope Factor
SQL	-	Sample Quantitation Limit
SVOC	-	Semivolatile Organic Compound
TAL	-	Target Analyte List
TBC	-	To Be Considered
TCE	-	Trichloroethene
TCL	-	Target Compound List
TES V	-	Technical Enforcement Support, USEPA Region V
TIC	-	Tentatively Identified Compound
UCL	-	Upper Confidence Limit
UF	-	Uncertainty Factor
USEPA	-	United States Environmental Protection Agency
VOC	-	Volatile Organic Compound
WA	-	Work Assignment

EXECUTIVE SUMMARY

BASELINE HUMAN HEALTH RISK ASSESSMENT

The Syosset Landfill Site is an inactive sanitary landfill and is located in central Nassau County, in the Town of Oyster Bay, Syosset, New York (see Figure 1-1 in Section 1.2). The site is rectangular in shape and encompasses approximately 35 acres. The Department of Public Works for the Town of Oyster Bay has offices and maintenance facilities located on approximately 18 acres lying adjacent to the east side of the landfill. A 6-foot high cyclone fence is located along the perimeter of the site. The site is bounded by the Long Island Expressway and Miller Place to the southeast, Cerro Wire & Cable Corporation to the southwest, and the Long Island Railroad to the northwest. A residential area and the South Grove Elementary School border the site to the northeast. Topographically, the site is relatively flat and similar in elevation to the surrounding area.

Refuse disposal at the site began in 1933. Between 1933 and 1967, there were no restrictions imposed on the types of waste accepted at the landfill. During this period, commercial, industrial, residential, demolition, agricultural, sludge materials, and ash waste were accepted. From 1967 until its closing in 1975, the landfill only accepted rubbish, brush, demolition debris, and scavenger cesspool wastes.

Several large companies have been identified as generators of large quantities of waste that were disposed of at the landfill over a period of years. Types of waste disposed of included heavy metals, solvents, organics, oils, plasticizers, and small amounts of polychlorinated biphenyls (PCBs). Thousands of tons of industrial sludge containing high concentrations of metals were also deposited in the landfill over the period of operation.

The landfill was closed on January 28, 1975 by the Nassau County Department of Health because of a suspected groundwater problem. The Site was placed on the Superfund National Priorities

List in September 1983. The remediation of the project was the responsibility of New York State Department of Environmental Conservation (NYSDEC) until October 1985. At that time, with NYSDEC's concurrence, USEPA assumed responsibility for the remediation of the Site.

The Syosset Landfill Site has been divided into two operable units for investigation and remediation purposes. The first operable unit (OU1) remedial investigation/feasibility study (RI/FS) was conducted by Geraghty & Miller, Inc. (Geraghty & Miller) for the Town of Oyster Bay, one of several potentially responsible parties (PRPs) associated with the site, from April 1987 through June 1988. The RI was developed to characterize on-site contamination and evaluate off-site migration pathways. Conclusions presented in the RI found that groundwater quality underneath and downgradient of the landfill had been impacted by leachate. Recommendations were made for determining the nature and extent of the off-site portion of the leachate plume. A Record of Decision (ROD) for the OU1 was signed on September 27, 1990. The ROD included provisions for covering the landfill with a geosynthetic membrane cap. Remedial activities are currently underway at the site (USEPA, 1990a).

Geraghty & Miller was again retained by the Town of Oyster Bay to conduct a second operable unit (OU2) RI which focused on the potential off-site environmental impacts of the Syosset Landfill. Specifically, an off-site groundwater and an off-site subsurface gas study was conducted at the site. Nine new groundwater monitoring wells (one on-site and three clusters of eight wells off-site) were installed and sampled as well as 12 pre-existing on-site monitoring wells. The results of the OU2 RI were submitted to the USEPA in report form on April 1994. Since on-site well data were already evaluated in the OU 1 risk assessment, only the results from the nine new groundwater monitoring wells were used in the risk assessment. Groundwater data from the 12 pre-existing monitoring wells located on-site were not used in the risk assessment because data from these wells were evaluated previously in the risk assessment conducted for OU1. The results from the off-site subsurface gas study will not be addressed in the risk assessment.

This baseline human health risk assessment document for the Syosset Landfill OU2 site provides

quantitative estimates, in accordance with current USEPA policy and guidance, of the carcinogenic risks (cancer causing) and noncarcinogenic health effects from human exposure to chemical contaminants in off-site groundwater in the absence of any site remediation and assuming no further institutional controls are put into place. This risk assessment process included data evaluation, exposure assessment, toxicity assessment, risk characterization, and uncertainty evaluation.

The data used in this report were obtained from:

- Second Operable Unit (OU2) Remedial Investigation report, Syosset Landfill, Syosset, New York (Geraghty & Miller, Inc. for the Town of Oyster Bay - April 1994).

Chemicals of potential concern were selected for groundwater samples for quantitative evaluation in the risk assessment. The selected chemicals are expected to be most representative of site conditions and the greatest contributors to potential human health impacts. The selected chemicals of potential concern are presented in Table 2-3. Three potential chemicals of concern, antimony, cadmium, and nickel were addressed qualitatively in the risk assessment because of field blank contamination associated with these chemicals.

A Draft Risk Assessment, dated August 4, 1995, was developed using the data obtained from the OU2 RI report. Around the same time, USEPA suggested that a third round of sampling be conducted to confirm the results reported during the earlier two rounds. A third round of groundwater sampling was conducted on July 27, 1995. Samples were analyzed for low-level volatile organic compounds. The results of the sampling effort (see Appendix F) indicated that similar contaminants detected in the earlier two rounds were still present at similar concentrations. These concentrations would have negligible impact on risk estimates. Therefore, the third round of sampling data is not included in the risk assessment.

Exposure scenarios (i.e., receptor groups and routes of exposure) were developed for the groundwater future-use scenario. Since groundwater at the site is not currently being used as a source of drinking water, the groundwater current-use scenario was not evaluated. The Nassau County Department of Health's Article IV concerns groundwater use in the area and states that "the Nassau Board of Health requires, insofar as possible, that all drinking water used by the public be provided by a public water system on the basis that such systems provide greater public health protection than that provided by a private water system" (Nassau County Department of Health, 1988). The exposure point concentration for each chemical to which a person may be exposed was estimated by using the 95 percent Upper Confidence Limit (UCL) on the mean calculation as defined by USEPA guidance. The 95 percent UCL is the most plausible upper bound concentration estimate based on statistical analysis of the data. Potential chemical intakes were then calculated using 95 percent UCL concentrations and reasonable maximum exposure (RME) variables.

The toxicity assessment presents general toxicological properties and identifies health effects criteria of selected chemicals of potential concern using the most current toxicological human health effects data. Chemicals with insufficient toxicological data were qualitatively addressed.

Carcinogenic risks and noncarcinogenic health effects were then characterized by integrating these exposure and toxicity assessments into quantitative expressions of carcinogenic risk and noncarcinogenic hazard index values. The quantitative results of this risk assessment should not be construed as absolute values, but instead as estimates of potential human health impacts. By using RME variables, conservative estimates of health risks/effects within the range of possible exposures were obtained. These estimates were then compared to the acceptable USEPA target risk range for carcinogens and noncarcinogens. For carcinogens, the USEPA target risk range is 10^{-4} (1 in 10,000) to 10^{-6} (1 in 1,000,000). For noncarcinogens, the USEPA target level is one. Based on consultation with the USEPA, a carcinogenic risk greater than the range of 10^{-4} to 10^{-6} is considered in exceedance of the target risk range.

The carcinogenic risk for potential future residential exposure to groundwater for adults via ingestion was within the upper-bounds of the USEPA's 10^{-4} to 10^{-6} target risk range. The chemicals 1,1-dichloroethene, tetrachloroethene, vinyl chloride, and arsenic were the main contributors to the overall risk. The carcinogenic risks for children via ingestion, as well as both adult and child exposures to groundwater via inhalation, did not exceed the target risk range.

Hazard index values for potential future residential (adult and child) exposure to groundwater via ingestion did not exceed the USEPA's target level of 1. The hazard index values for potential future residential (adult and child) exposure to groundwater via inhalation were not calculated due to the lack of established inhalation reference doses for the chemicals of potential concern. The range of detections for the chemicals of potential concern selected in groundwater were compared to Applicable or Relevant and Appropriate Requirements (ARARs), which include federal and state maximum contaminant levels (MCLs) (see Table 5-3).

In accordance with standard risk assessment practice, uncertainty in risk assessment is evaluated both qualitatively and quantitatively. A quantitative evaluation, involving the calculation of central tendencies (averages), was performed for those exposure scenarios showing carcinogenic risks or noncarcinogenic hazard index values above the USEPA target levels.

Risk-based preliminary remediation goals (PRGs), as defined by USEPA guidance, were not developed for the residential groundwater exposure scenario since no chemicals exceeded the USEPA's 10^{-4} to 10^{-6} target risk range for carcinogens or hazard index of 1 for noncarcinogens. In addition, all chemicals of potential concern have established MCLs. Available MCLs for chemicals of potential concern in groundwater, as stated above, are presented in Table 5-3.

A summary of the results of the quantitative evaluation of potential carcinogenic risks and noncarcinogenic health effects has been presented. Risks and hazards are discussed in detail in Section 5.0 and are summarized in Tables 5-1 and 5-2.

1.0 INTRODUCTION

1.1 Overview

Under the Alternative Remedial Contracting Strategy (ARCS II) contract, Contract No. 68-W9-0024, CDM Federal Programs Corporation (CDM Federal) received work assignment (WA) No. 074-2P39 from the U.S. Environmental Protection Agency (USEPA) Region II to provide technical oversight for the USEPA at the Syosset Landfill site. This assignment includes performance of a baseline human health risk assessment to characterize site risk as part of the Remedial Investigation/Feasibility Study (RI/FS) currently being performed for the second operable unit (OU2) at the site located in Syosset, New York. The focus of the OU2 RI/FS is offsite groundwater.

The focus of this risk assessment is to evaluate the potential human exposures to groundwater to determine if adverse human health impacts may occur in the future. This risk assessment was performed under the assumption that no additional corrective action will occur in the future and that presently site groundwater is not used for human consumption or bathing, based on information provided by the Nassau County Department of Health (NCDOH) to the USEPA Risk Assessment Specialist, (Olsen, 1995). Specifically, the NCDOH's Article IV concerns groundwater use in the area and states that "the Nassau Board of Health requires, insofar as possible, that all drinking water used by the public be provided by a public water system on the basis that such systems provide greater public health protection than that provided by a private water system (Nassau County Department of Health, 1988).

This report was prepared in accordance with the USEPA Region II and federal guidance documents and the on-line data base listed below. Additional references are listed in the reference section at the end of the report.

- Risk Assessment Guidance for Superfund (RAGS): Human Health Evaluation Manual (HHEM) (USEPA, 1989b).

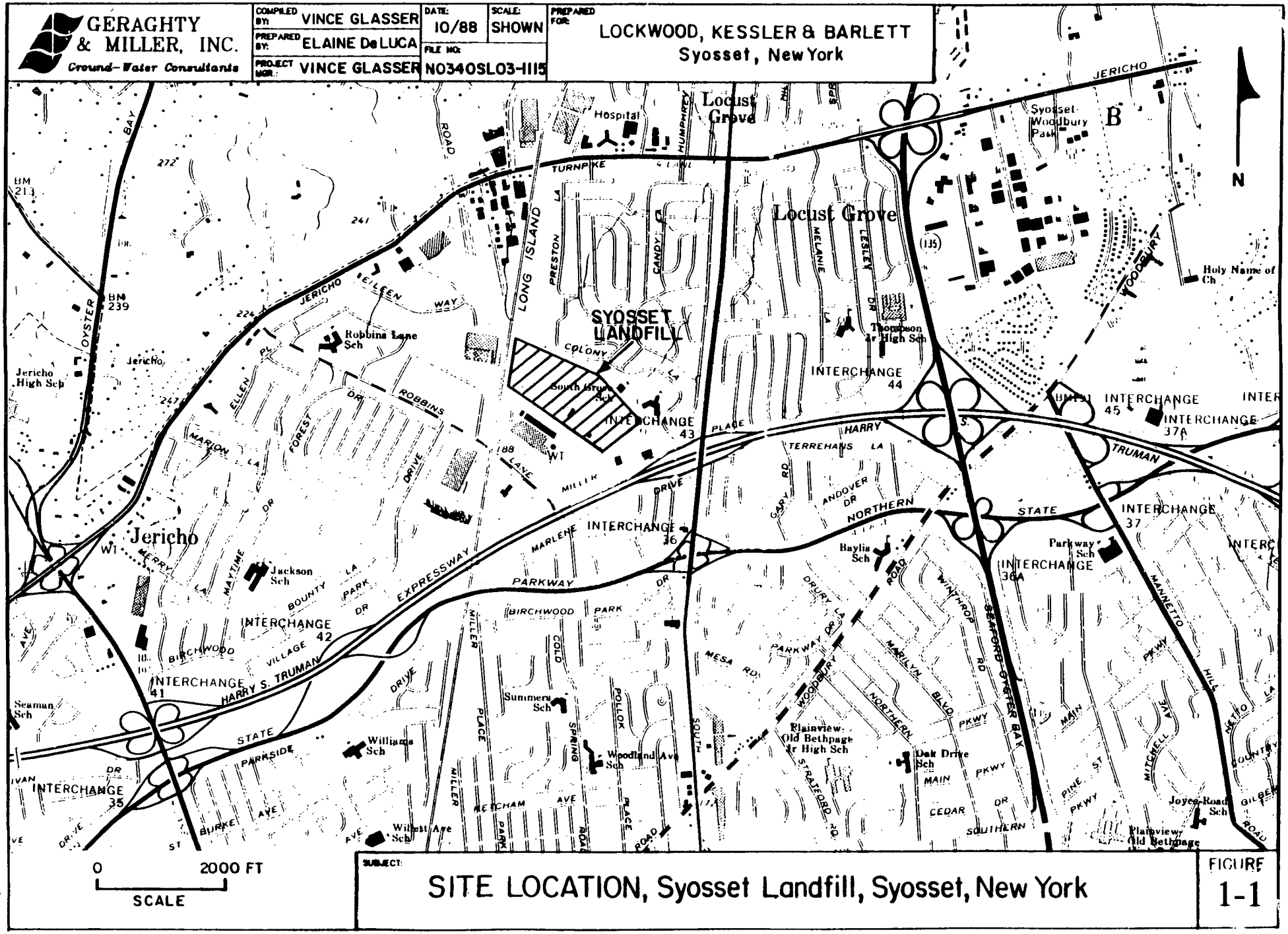
- Exposure Factors Handbook (USEPA, 1989c).
- Guidance for Data Useability in Risk Assessment (USEPA, 1992c).
- Dermal Exposure Assessment: Principles and Applications - Interim Report (USEPA, 1992d).
- Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors (USEPA, 1991a).
- Integrated Risk Information System On-line Data Base of Toxicity Measures (IRIS, 1995).
- Health Effects Assessment Summary Tables (HEAST) (USEPA, 1994).

1.2 Site Description

The Syosset Landfill site is an inactive sanitary landfill, approximately 38 acres in size, and is located in central Nassau County, Syosset, New York (Figure 1-1). Refuse disposal at the site began in 1933 and continued until 1975 when operations ceased. Between 1933 and 1967, no restrictions were imposed on the types of wastes accepted at the site. Waste types accepted during this period included commercial, industrial, residential, demolition, agricultural, sludge materials, and ash. From 1967 until its closing in early 1975, the landfill only accepted rubbish, brush, demolition debris, and scavenger cesspool wastes. The site also includes offices and maintenance facilities for the Town of Oyster Bay Department of Public Works. This area is located to the east, immediately adjacent to the landfill, and occupies approximately 18 acres.

During its operation, the landfill was excavated into two cells to approximately 60 to 90 feet below land surface and was backfilled with garbage. There is also evidence that buried combustible fill materials were ignited and allowed to burn in portions of the landfill.

The landfill was closed on January 28, 1975 by the NCDOH because of a suspected groundwater



SOURCE: OU2 REMEDIAL INVESTIGATION REPORT, SYOSSET LANDFILL BY GERAGHTY & MILLER (APRIL 1994).

pollution problem. The site was placed on the Superfund National Priorities List (NPL) in September 1983. The remediation of the site was the responsibility of the New York State Department of Environmental Conservation (NYSDEC) until October 1985. At that time, with the NYSDEC's concurrence, the USEPA assumed responsibility for the remediation of the site.

Several large companies have been identified as generators of large quantities of wastes that were disposed of at the landfill over a period of years. According to information in the USEPA's possession, Hooker Chemicals and Plastics (Hooker) disposed of approximately 48 tons of hazardous wastes at the landfill from 1946 to 1968. The wastes included heavy metals, solvents, organics, oils and sludges, plasticizers, and small amounts of polychlorinated biphenyls (PCBs). Hooker was acquired by Occidental Chemical Corporation in 1982. The USEPA's records also indicate that Cerro disposed of between 700 and 1,080 tons annually of industrial sludges at the landfill from 1950 to 1975. These sludges contained high concentrations of metals, including iron, copper, chromium, zinc, lead, cadmium, and nickel. The USEPA's records also indicate that Columbia Corrugated Container Company disposed of approximately 4,889 tons of sludge from its industrial waste treatment plant at the landfill from 1949 to 1966. This sludge consisted primarily of hydroxides of chromium, aluminum, and iron. It should be noted that the above-mentioned generators are only some of the generators who are known to have disposed of hazardous substances at the landfill.

In January 1983, Environmental Resources Management-Northeast (ERM) prepared a report summarizing the results of a study that it performed for the NCDOH. The report concluded that the groundwater underlying and near the site was being impacted by the landfill leachate. Heavy metals concentrations of arsenic, cadmium, chromium, and lead were detected at levels exceeding the New York State drinking water standards.

The Town of Oyster Bay, a potentially responsible party (PRP), approached the USEPA in 1986 and expressed an interest in performing the RI/FS. Subsequently, the USEPA mailed general notice letters to nine additional PRPs. All PRPs declined to perform the RI/FS.

On June 19, 1986, the USEPA and the Town of Oyster Bay entered into an Administrative Order on Consent, Index No. II CERCLA-60203 (the Order). The Order required the Town of Oyster Bay to conduct an RI/FS for the site with provisions for performing investigations of chemical contaminant migration away from the landfill property, as deemed necessary. Since that time, the USEPA has separated the cleanup of the site into two phases or operable units. The first operable unit (OU1) addresses the identification and abatement of the source of site contamination at the landfill property. The second operable unit (OU2) will assess the nature and extent and need for abatement, if any, of migration of contaminants from the landfill property into nearby groundwater.

A Record of Decision (ROD) for OU1 was signed on September 27, 1990. The ROD included provisions for covering the landfill with a geosynthetic membrane cap consistent with New York State Sanitary Landfill closure requirements (USEPA, 1990a). A Consent Decree was negotiated with the Town of Oyster Bay in September 1990 for implementation of the OU1 ROD.

Field work for the OU1 RI was conducted by Geraghty & Miller, Inc. (Geraghty & Miller) for the Town of Oyster Bay from April 1987 through June 1988. The RI consisted of three studies: an on-site groundwater study; a landfill dimension study; and a subsurface gas study. Components of these studies included installing nine groundwater monitoring wells to supplement the existing six monitoring wells at the site; installing gas monitoring wells; drilling and sampling landfill material; and sampling groundwater and landfill gas monitoring wells. The RI was developed to characterize potential on-site chemical contamination and evaluate off-site migration pathways.

During the RI, the fifteen on-site monitoring wells were sampled in two rounds for selected USEPA Priority Pollutants including volatile organic compounds (VOCs), extractable organics, PCBs, and filtered and unfiltered metals. These data were compiled and evaluated in the Final Health and Endangerment Assessment for OU1 conducted by CDM Federal TES V team member, Versar (July 9, 1990). The results of the assessment generally showed a low likelihood of adverse impacts from noncarcinogenic chemicals at the site. The total upper-bound carcinogenic risks for

adults and school children were within the USEPA's target risk range of 10^{-4} to 10^{-6}.

During the OU1 RI, leachate-impacted groundwater was detected beneath the landfill at the northern (downgradient) property boundary, and elevated concentrations of methane were detected at the southeastern part of the landfill. Recommendations in the OU1 RI were made to determine the nature and extent of the off-site portion of the leachate plume. Geraghty & Miller was again retained to conduct the OU2 RI and to focus on the potential off-site environmental impacts of the Syosset Landfill. The OU2 RI was conducted from October 1992 to March 1994 and consisted of an off-site groundwater study and an off-site subsurface gas study. The purposes of the off-site groundwater study were to determine the off-site extent of a leachate plume that may be emanating from the landfill, to confirm the direction of groundwater flow, and to determine the plume thickness. The purpose of the off-site subsurface gas study was to determine the extent of off-site subsurface gas migration from the landfill. The OU2 RI included installation of nine wells at three off-site locations and one on-site well. It also included two rounds of sampling of existing and new wells.

1.3 Scope of the Risk Assessment

This baseline risk assessment presents an evaluation of the potential risks and hazards to human health that may exist at the site in the future in the absence of any further remediation (i.e., no further action). The following documents serve as the primary sources of site characterization/background and analytical data for the baseline risk assessment. The groundwater analytical data were generated from RI field sampling activities which were conducted by Geraghty & Miller from October 1992 through March 1994.

- Second Operable Unit (OU2) Remedial Investigation Report, Syosset Landfill, Syosset, New York (Geraghty & Miller, Inc. for the Town of Oyster Bay - April 1994).
- Draft Interim Remedial Investigation Report for OU1, Syosset Landfill, Syosset,

New York (Geraghty & Miller, Inc. - August 1989).

- Final Health and Endangerment Assessment for OU1, Syosset Landfill site, Oyster Bay, Long Island, New York (CDM Federal Programs Corporation - Versar July 9, 1990).

This baseline risk assessment was prepared utilizing, to the maximum extent possible, site-specific data to define sources, pathways, receptors, chemical concentrations, and exposure input terms. Where specific data were not available, professional judgement was used to select input terms that are assumed to reflect actual site conditions. By having an adequate data base, the need for using conservative sources, pathways, chemical concentrations, and exposure input terms has been minimized.

1.4 Organization of the Risk Assessment

Data Evaluation

In the first step of the assessment, Data Evaluation, a subset of the various chemicals identified at the site was selected for detailed analysis. The primary selection criteria for these chemicals included 1) chemical concentrations in groundwater; 2) a chemical concentration-toxicity screen; 3) frequency of detection; 4) the physical/chemical parameters; 5) the degree of toxicity, mobility, and persistence of each chemical in the environment; and 6) historical information about site activities and the chemicals reliably associated with these activities. This procedure is described in detail in Data Collection and Evaluation (Section 2.0) of this risk assessment. Appendix E contains the site data utilized in the risk assessment which were collected during the field investigation.

Exposure Assessment

In the second step, Exposure Assessment, routes of exposure were identified and quantitative estimates of the magnitude, frequency, and duration of exposure were made. Numerous pathways through which chemical contaminants could possibly migrate from potential sources to existing receptors were identified. Receptor groups (i.e., human populations) that might potentially be exposed as a result of the presence of one or more chemicals in the environment were also identified. Typically, these receptor populations include persons who might be exposed via ingestion of, dermal contact with, or inhalation of chemicals in or released from groundwater. Receptors who might be exposed under potential future-use scenarios were evaluated, as appropriate.

Exposure point concentrations for chemicals of potential concern were estimated based on the 95 percent Upper Confidence Limit (UCL) on the arithmetic mean (Appendix A).

Chronic daily chemical intakes via ingestion and/or inhalation routes were estimated based on the 95 percent UCL estimate and site-specific, medium-specific, and receptor-specific intake variables. Exposures were estimated for the RME which employs the 95 percent UCL (exposure point) concentration and RME assumptions (i.e., 90^{th} and 95^{th} percentile parameters). The RME is the highest exposure that is reasonably expected to occur at a site (USEPA, 1989b).

It should be noted that this risk assessment assumes that no reduction in exposure concentrations occurs due to natural physical/chemical processes, site remediation, or institutional controls. The results of the exposure assessment evaluation are provided in the Exposure Assessment (Section 3.0) of this risk assessment.

Toxicity Assessment

The third step of the risk assessment consisted of the Toxicity Assessment. The purpose of the

toxicity assessment was to weigh available toxicological evidence regarding the potential for a particular chemical contaminant to cause adverse health effects in exposed individuals and to provide, where possible, an estimate of the relationship between the extent of exposure to a chemical contaminant and the increased likelihood and/or severity of adverse effects (USEPA, 1989b).

The USEPA has performed the toxicity assessment step for numerous chemicals and has made available the resulting toxicity information and toxicity values, which have undergone extensive peer review; however, data analysis and interpretation are still required when applying these values to a site. These established toxicity values were obtained from:

- Integrated Risk Information System (IRIS, 1995).
- Health Effects Assessment Summary Tables (USEPA, 1994).
- Information from discussions between the Region II Risk Assessment Specialist and the staff at the National Center for Environmental Assessment in Cincinnati (formerly the ECAO).

A toxicological profile for each of the chemicals of potential concern was developed using the USEPA toxicity assessments and accompanying values. The toxicity data were evaluated to determine if they were appropriate for use in the risk assessment, or if they needed to be modified. When toxicity values were not available for a specific chemical, the chemical was qualitatively discussed. The toxicity values and the limitations of use of the toxicity values are described in the Toxicity Assessment (Section 4.0) of this risk assessment. Toxicological profiles are presented in Appendix B of this report.

Risk Characterization

In the last step of the risk assessment, Risk Characterization, the chronic daily intake for each chemical to which a given receptor group might be exposed was compared to a concentration known or suspected to present some health risk or hazard. Quantitative estimates of the

carcinogenic risks and noncarcinogenic health effects (hazard index values) associated with each exposure pathway are presented along with total estimated risks and hazard index values for potential future uses of the site.

The risks resulting from exposures to carcinogens were estimated based on the following assumptions.

- a linear relationship exists between the intake of a carcinogenic substance over a lifetime and the probability of cancer (the linearized multistage model of carcinogenesis) and;
- cancer risks from exposures to all carcinogens via all intake routes are additive.

The potential for noncarcinogenic effects was evaluated by comparing an exposure level over a specified time period with a reference dose derived for a similar exposure period. Section 5.0 of this risk assessment presents the Risk Characterization. Spreadsheet calculations are presented in Appendix C of this risk assessment.

Due to the number of assumptions that are required during the risk assessment process, there will inevitably be some degree of uncertainty associated with the baseline risk and hazard estimates. These uncertainties are addressed both qualitatively and quantitatively (i.e., central tendency calculations) in Section 6.0 Uncertainties in Risk Assessment. Central tendency calculations are presented in Appendix D of this report.

Risk-based preliminary remediation goals (PRGs) are initial concentration goals for individual chemicals for specific medium and land use combinations. Whether PRGs are required for a site depends on the calculated site risks and hazard estimates, the existence of Applicable or Relevant and Appropriate Requirements (ARARs), and the existence of superseding USEPA guidance on action levels. PRGs for this site were not calculated since no carcinogenic risks or hazard index values exceeded the USEPA's target level of 10^{-4} to 10^{-6} for carcinogens or one for

noncarcinogens. In addition, all chemicals of potential concern have established federal and state maximum contaminated levels (MCLs).

A summary of the results of the baseline human health risk assessment is presented in Section 7.0.

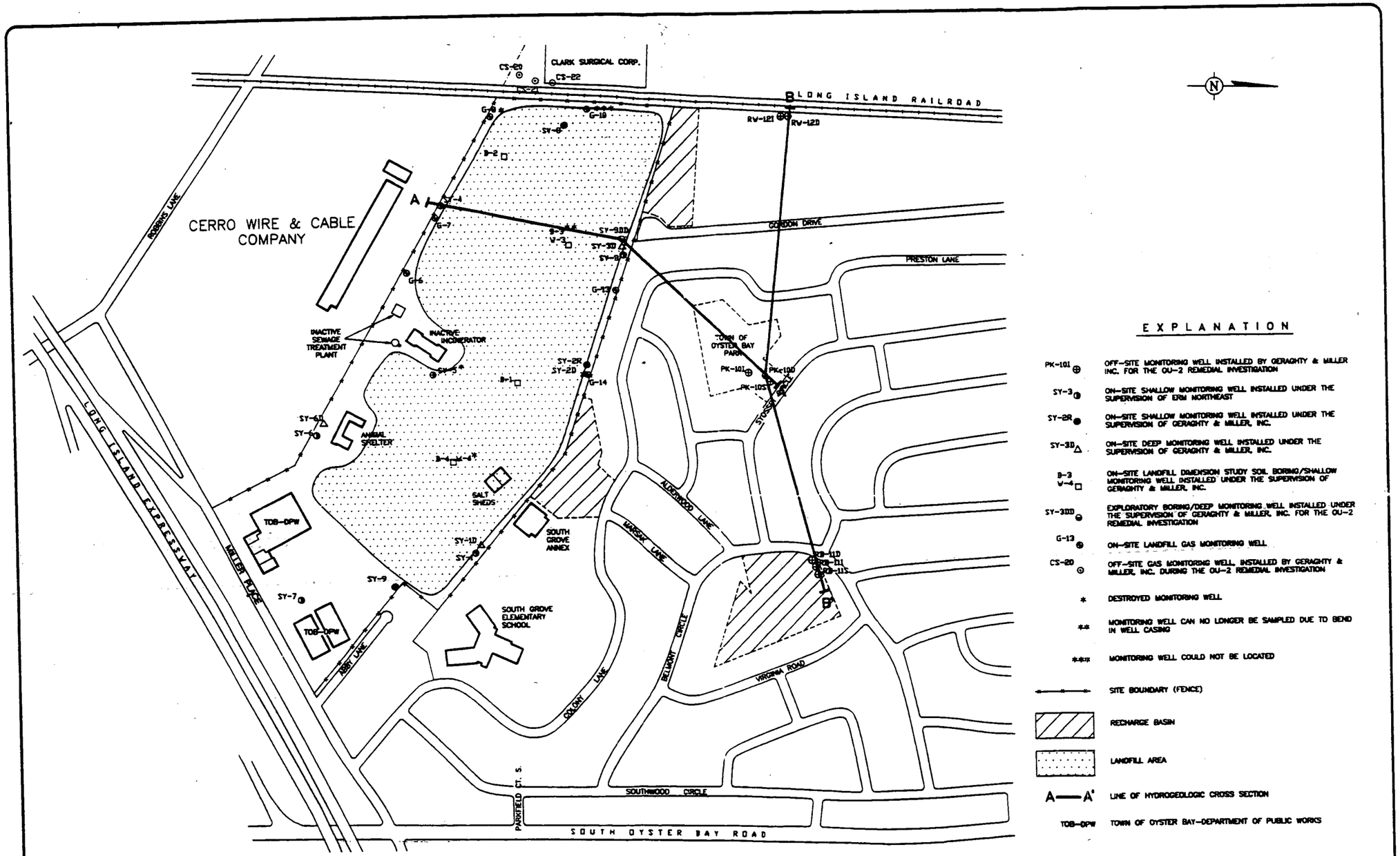
2.0 DATA COLLECTION AND EVALUATION

The OU2 RI activities conducted by Geraghty & Miller from October 1992 through March 1994 serve as the source of information for site characterization and analytical data for this risk assessment. Additional sources of information for site characterization and background include the Draft Interim RI report for OU1 prepared in August 1989 by Geraghty & Miller and the Final Health and Endangerment Assessment for OU1 prepared by CDM Federal TES V team member, Versar dated July 9, 1990.

This section presents a summary of the results of the sampling and analysis activities conducted to characterize groundwater conditions at the Syosset Landfill site. The results of these activities are presented along with the criteria used to identify chemicals of potential concern and a list of chemicals of potential concern selected on the basis of these criteria.

All groundwater data collected at the site which were evaluated in this risk assessment are presented in Appendix E. Per USEPA direction, the groundwater sampling results selected for evaluation in the risk assessment include those collected from the new monitoring wells installed as part of the OU2 RI. A total of nine wells were installed at four different locations. One well is located on-site; three well clusters are located off-site. These results have been summarized in tabular form and are presented in Section 2.2.2. The locations of the sampled wells are presented in Figure 2-1. The data summary table presents all chemicals detected, the associated frequencies and ranges of detections, the locations of the maximum detected concentrations, and the range of non-detect concentrations.

A Draft Risk Assessment, dated August 4, 1995, was developed using the data obtained from the OU2 RI report. Around the same time, USEPA suggested that a third round of sampling be conducted to confirm the results reported during the earlier two rounds. A third round of groundwater sampling was conducted on July 27, 1995. Samples were analyzed for low-level volatile organic compounds. The results of the sampling effort (see Appendix F) indicated that



GERAGHTY & MILLER, INC.
Environmental Services

DRAWING CONFIDENTIAL: THIS DRAWING AND ALL INFORMATION CONTAINED THEREON IS AND SHALL REMAIN THE PROPERTY OF GERAGHTY & MILLER, INC. AS AN INSTRUMENT OF PROFESSIONAL SERVICE. THIS INFORMATION SHALL NOT BE USED IN WHOLE OR IN PART WITHOUT THE FULL KNOWLEDGE AND PRIOR WRITTEN CONSENT OF GERAGHTY & MILLER, INC.

SCALE VERIFICATION
THIS BAR REPRESENTS ONE INCH ON THE ORIGINAL DRAWING:
USE TO VERIFY FIGURE REPRODUCTION SCALE

PROJECT NO.: NY0223008	FILE NO: 1584
DRAWING: LINEVELL	PLOT SIZE: 1"=300'
DRAFTED BY: VC	DATE: 3/8/94
CHECKED BY: SZ	DATE:
APPROVED BY: VC	DATE:

LOCATIONS OF GROUNDWATER MONITORING WELLS, GAS MONITORING WELLS, SOIL BORINGS, AND LINES OF HYDROGEOLGIC CROSS SECTION, SYOSSET LANDFILL SYOSSET, NEW YORK

FIGURE 2-1

SOURCE: OU2 REMEDIAL INVESTIGATION REPORT, SYOSSET LANDFILL BY GERAGHTY & MILLER (APRIL 1994).

similar contaminants detected in the earlier two rounds were still present at similar concentrations. These concentrations would have negligible impact on risk estimates. Therefore, the third round of sampling data is not included in the risk assessment.

All analytical data generated during the Geraghty & Miller OU2 RI, including tentatively identified compounds (TICs), which were utilized in this risk assessment, were validated in accordance with USEPA Region II protocols. Accordingly, all data qualifiers have been included in the data summary tables for completeness.

Data collected from groundwater to which potential future human exposure was considered likely and where exposure pathways were considered complete formed the basis of the quantitative risk assessment. These data were used to estimate exposure point concentrations as discussed in Section 3.3 and carcinogenic risk and noncarcinogenic hazard estimates as presented in Section 5.0.

2.1 Summary of Groundwater Sampling and Analysis Activities

The environmental medium that was sampled and that has been quantitatively evaluated in this risk assessment is groundwater. The following is a summary of the specific data set for groundwater used in the evaluation of potential future human health risks and hazards.

Geraghty & Miller conducted the OU2 RI of the Syosset Landfill site on behalf of the Town of Oyster Bay. The OU2 RI focused on determining the nature and extent of a leachate plume that may have been emanating from the landfill, confirming the direction of groundwater flow, and determining plume thickness. The OU2 RI field work was performed from October 1992 to March 1994. The field work included installation of nine new monitoring wells at three off-site locations (well clusters PK, RB, and RW) and one on-site location (well SY-3DD). It also included two rounds of sampling of 12 pre-existing on-site wells and the nine newly installed wells. The first round of groundwater samples was collected from November 1 through November 5, 1993 and

the second round was collected from November 29 through December 3, 1993. Duplicates were also collected during both rounds of sampling. The locations of these wells are presented on Figure 2-1. Only the data from the groundwater samples collected from the nine newly installed wells have been used in the risk assessment. Data from the 12 pre-existing wells were previously evaluated as part of the OU1 risk assessment.

The groundwater samples collected from the nine newly installed wells were analyzed for an abbreviated list of USEPA Priority Pollutants including volatile organic compounds (VOCs) and filtered and unfiltered metals. VOCs were analyzed following USEPA Method 524.2, Revision 3.0 (USEPA, 1989a), with USEPA Region II modifications. Selected metals were analyzed for following the USEPA Contract Laboratory Program (CLP) Statement of Work (SOW) for Inorganic Analyses, Document Number ILM02.1 (USEPA, 1990b). Validation of the VOC data was performed by the PRPs using USEPA Region II Standard Operating Procedures (SOP) No. HW-6 Revision 8 for organic data validation (USEPA, 1992a). Validation of the metals data was performed using USEPA Region II SOP No. HW-2 Revision 11 for inorganic data validation (USEPA, 1992b). In general, the quality of the data was found to be acceptable with the qualifications described in the data validation report.

With the exception of the qualifications provided in the data validation report, the PRPs concluded that the quality of the data was generally found to be acceptable. CDM Federal has noted, however, that field blank contamination may be a problem for the inorganics antimony, cadmium, and nickel; blank contamination is discussed in detail in Section 2.3.1. These inorganics are addressed qualitatively in Section 6.0, Uncertainties in Risk Assessment.

Groundwater results from the nine newly installed monitoring wells sampled by Geraghty & Miller, including duplicates, have been used to produce a data summary table and to calculate a chemical concentration-toxicity screen and exposure point concentrations.

2.2 Summary of Sampling and Analysis Results

2.2.1 Data Quality

As part of the data evaluation process, the quality of site data was evaluated. The Geraghty & Miller data collected as part of the OU2 RI and used in this risk assessment (nine new monitoring wells consisting of three off-site well clusters and one on-site well) were validated in accordance with USEPA Region II data validation protocols. However, it should be noted that the data for certain samples and analytes that were not rejected during validation were qualified for the following reasons:

- The "J" qualifier for all chemicals indicates that the reported concentration is estimated.
- The "B" qualifier indicates for organic chemicals that the reported concentration is estimated since it was detected in both the sample and in the associated blank; for inorganics, the "B" qualifier indicates that the reported concentration is less than the contract required detection limit and greater than the instrument detection limit.
- The "U" qualifier for all chemicals indicates that the chemical is not detected at the reported detection limit.

In general, data with qualifiers that indicate uncertainties in concentrations but not in identity were utilized in this risk assessment. Rejected data, qualified with an "R", were not used in this risk assessment since chemical identification and concentration are uncertain. Data qualified with a "U" were used in the risk assessment, as appropriate, in producing data summary tables and in calculating 95 percent UCLs.

2.2.2 Chemicals Detected in Groundwater

A single site groundwater data summary is presented in Table 2-1. Groundwater samples

07/11/95
DSUMM-GW.XLS

TABLE 2-1

SYOSSET LANDFILL SITE
SUMMARY OF CHEMICALS IN GROUNDWATER

CONCENTRATION (ug/l)

	Frequency of Detection	Range of Detected Concentrations		Location of Maximum	Range of Non-Detect Concentrations	
		Minimum	Maximum		Minimum	Maximum
CHEMICALS						
VOCs						
Dichlorodifluoromethane	4/18	0.20 J	2.65 J	RB-11I-R2-AV	1.00 UJ	5.00 U
Vinyl Chloride	5/18	0.60 J	17.0	RW-12D-R2	1.00 U	2.00 U
1,1-Dichloroethene	8/18	0.20 J	26.5	RW-12I-R2-AV	1.00 U	1.00 U
1,1-Dichloroethane	11/18	0.30 J	17.0	RW-12I-R2-AV	1.00 U	1.00 U
cis-1,2-Dichloroethene	10/18	0.30 J	5.80	RW-12I-R2-AV	1.00 U	1.00 U
1,1,1-Trichloroethane	6/18	2.50	75.0	RW-12I-R2-AV	1.00 U	1.00 U
Benzene	5/18	0.40 J	0.90 J	RW-12D-R2	1.00 U	2.00 U
Trichloroethene	10/18	0.50 J	9.85	RW-12I-R2-AV	1.00 U	1.00 U
1,2-Dichloropropane	1/18	1.00	1.00	RW-12D-R2	1.00 U	5.00 U
Toluene	14/18	0.30 J	12.5	RW-12I-R2-AV	1.00 U	2.00 U
Tetrachloroethene	10/18	1.30	110	RW-12I-R2-AV	1.00 U	1.00 U
Chlorobenzene	5/18	0.30 J	18.5	PK-10I-R1-AV	1.00 U	1.00 U
meta and/or para-Xylenes	2/18	0.10 J	0.10 J	RB-11D-R1	1.00 U	5.00 U
Trichlorofluoromethane	2/18	0.90 J	1.20 J	RW-12I-R2-AV	1.00 U	2.00 U
Inorganics						
Antimony	1/18	25.0 B	25.0 B	SY-3DD-R1	21.0 U	21.0 U
Arsenic	5/18	1.50 B	9.70 B	PK-10D-R1	1.00 U	1.00 U
Barium	17/18	2.50 B	75.2 B	RW-12D-R2	2.00 U	2.00 U
Cadmium	5/18	2.00 B	2.90 BJ	RB-11I-R1-AV	2.00 U	2.00 U
Chromium	9/18	3.50 BJ	14.8	RB-11I-R1-AV	3.00 U	3.00 U
Copper	8/17	7.00 B	38.8	PK-10S-R1	7.00 U	7.00 U
Iron	13/13	179	5,380	PK-10S-R2	-	-
Lead	18/18	1.70 BJ	10.1 J	PK-10S-R1	-	-
Nickel	9/18	10.1 B	34.2 B	SY-3DD-R2	11.0 U	11.0 U
Potassium	16/18	787 B	53,450	PK-10I-R2-AV	473 U	473 U
Selenium	2/18	5.40	8.40 BJ	RW-12D-R1	2.00 UJ	2.00 UJ
Silver	1/18	2.30 B	2.30 B	SY-3DD-R1	2.00 U	2.00 U
Sodium	18/18	4,220 B	236,000 J	PK-10I-R2-AV	-	-
Zinc	16/16	30.4	178 J	PK-10S-R1	-	-

Sample Group:

PK-10D-R1, PK-10D-R2, PK-10I-R1-AV, PK-10I-R2-AV, PK-10S-R1, PK-10S-R2, RB-11D-R1, RB-11D-R2, RB-11I-R1-AV, RB-11I-R2-AV, RB-11S-R1, RB-11S-R2, RW-12D-R1, RW-12D-R2, RW-12I-R1-AV, RW-12I-R2-AV, SY-3DD-R1, SY-3DD-R2.

collected from shallow, intermediate, and deep zones of the Magothy aquifer were evaluated as one group since the zones appear to be hydraulically connected. Samples having duplicate results were given the suffix -AV in the data tables to differentiate the components of the averaged result.

The results of the analysis of 18 groundwater samples collected at the Syosset Landfill site are presented in Table 2-1. Fourteen VOCs, including primarily chlorinated aliphatic and aromatic chemicals, were detected in at least one sample. The most frequently detected VOCs were toluene (14 of 18 samples), and 1,1-dichloroethane (11 of 18 samples). The chemicals detected at the highest concentrations were tetrachloroethene (110 ug/l), and 1,1,1-trichloroethane (75.0 ug/l). The maximum detections of these chemicals were reported in sample RW-12I-R2-AV.

Fourteen inorganics were detected in the site groundwater samples. Four inorganics including iron, lead, sodium, and zinc were detected in each of the valid samples for inorganics. The highest reported concentrations in these samples for the chemicals of potential concern (see Table 2-3) were 9.70 B ug/l for arsenic and 8.40 BJ ug/l for selenium. These maximum detections were reported in samples PK-10D-R1 and RW-12D-R1, respectively.

2.3 Criteria for the Selection of Chemicals of Potential Concern

Due to the large number of chemicals detected at the Syosset Landfill site, the number of chemicals retained for quantitative analysis in this risk assessment was reduced to the most significant (i.e., greatest contributors to risk/hazards). If all chemicals were retained for analysis, the resulting document would be unduly complex and could obscure the dominant risks/hazards associated with the site. Therefore, chemicals of potential concern were selected based on procedures specified in RAGS Part A (USEPA, 1989b) and on professional judgement. The primary considerations for selection or elimination were as follows:

- frequency of detection in groundwater

- historical site information/activities (i.e., site-relatedness)
- chemical concentration - toxicity screen
- sample chemical detections relative to blank chemical detections
- chemical toxicity (potential carcinogenic and noncarcinogenic effects, weight-of-evidence for potential carcinogenicity)
- chemical properties (i.e., mobility, persistence, and bioaccumulation)
- significant exposure routes

The frequency of detection is defined as the number of detections (hits) divided by the total number of valid sample analyses. A frequency of detection of five (5) percent is generally utilized as the minimum cutoff point in risk assessment. Since 18 samples were used in the risk assessment, the frequency of detection criteria is not applicable since a single detection of any chemical would result in a frequency of detection greater than five (5) percent. A number of metals were detected in nearly all groundwater samples analyzed for metals, including, but not limited to, the essential nutrients iron and sodium. The potential toxicity of the essential nutrients is significantly lower than other inorganics detected at the site. In general, more data are available for these minerals with regard to identifying dietary intake rather than toxicity. These minerals are also typically obtained via food and mineral supplements and are homoeostatically regulated to maintain appropriate body functions. Therefore, these minerals were not selected as chemicals of potential concern in this risk assessment (USEPA, 1989b).

The potential health impact of a chemical is related to the relationship of concentration and toxicity. Therefore, a chemical concentration - toxicity screening procedure was performed for all chemicals detected in site groundwater to aid in the determination of which chemicals were likely to contribute significantly to potential risks and hazards (Table 2-2).

Individual chemical scores (or risk factors) were calculated for groundwater as follows:

8/2/95
TOXSCRNGW.XLS

TABLE 2-2

SYOSSET LANDFILL SITE OU 2
CHEMICAL CONCENTRATION - TOXICITY SCREEN
GROUNDWATER

CARCINOGENS:

CHEMICAL	Chemical of Potential Concern (Contributes >1%)	Maximum Detected Concentration (mg/l)	Slope Factor (mg/kg-day)-1		Risk Factor (unitless)	Contribution to Total Risk for Matrix (Percent)
Vinyl Chloride	YES	1.70E-02	1.9E+00	(2)	3.23E-02	47.03%
1,1-Dichloroethene	YES	2.65E-02	6.0E-01	(1)	1.59E-02	23.15%
1,2-Dichloropropane	no	1.00E-03	6.8E-02	(2)	6.80E-05	0.10%
Trichloroethene	no	9.85E-03	1.1E-02	(4)	1.08E-04	0.16%
Benzene	no	9.00E-04	2.9E-02	(1)	2.61E-05	0.04%
Tetrachloroethene	YES	1.10E-01	5.2E-02	(3)	5.72E-03	8.33%
Arsenic	YES	9.70E-03	1.5E+00	(1)	1.46E-02	21.19%
			TOTAL RISK FACTOR	=	6.87E-02	100%

NOTES:
(1) Toxicity values were obtained from IRIS (on-line July 28, 1995).
(2) Toxicity values were obtained from HEAST Annual FY-1994.
(3) Toxicity values were verified by Marian Olsen, the USEPA Region II Risk Assessment Specialist, who consulted the National Center for Environmental Assessment on July 31, 1995.
(4) Toxicity value was verified by the Superfund Health Risk Technical Support Center (now known as the National Center for Environmental Assessment) on October 27, 1994 and was confirmed by Marian Olsen, the USEPA Region II Risk Assessment Specialist, on July 10, 1995.

8/2/95
TOXSCRNGW.XLS

TABLE 2-2

SYOSSET LANDFILL SITE OU 2
CHEMICAL CONCENTRATION - TOXICITY SCREEN
GROUNDWATER

NONCARCINOGENS:

CHEMICAL	Chemical of Potential Concern (Contributes >1%)	Maximum Detected Concentration (mg/l)	Reference Dose (mg/kg-day)		Risk Factor (unitless)	Contribution to Total Risk for Matrix (Percent)
Dichlorodifluoromethane	no	2.65E-03	2.0E-01	(1)	1.33E-02	0.01%
1,1-Dichloroethene	YES	2.65E-02	9.0E-03	(1)	2.94E+00	2.36%
1,1-Dichloroethane	no	1.70E-02	1.0E-01	(2)	1.70E-01	0.14%
cis-1,2-Dichloroethene	no	5.80E-03	1.0E-02	(2)	5.80E-01	0.46%
Trichloroethene	YES	9.85E-03	6.0E-03	(3)	1.64E+00	1.31%
Tetrachloroethene	YES	1.10E-01	1.0E-02	(1)	1.10E+01	8.81%
Toluene	no	1.25E-02	2.0E-01	(1)	6.25E-02	0.05%
Chlorobenzene	no	1.85E-02	2.0E-02	(1)	9.25E-01	0.74%
m/p-Xylenes	no	1.00E-04	2.0E+00	(3)	5.00E-05	0.00%
Trichlorofluoromethane	no	1.20E-03	3.0E-01	(1)	4.00E-03	0.00%
Antimony	YES	2.50E-02	4.0E-04	(1)	6.25E+01	50.04%
Arsenic	YES	9.70E-03	3.0E-04	(1)	3.23E+01	25.89%
Barium	no	7.52E-02	7.0E-02	(1)	1.07E+00	0.86%
Cadmium	YES	2.90E-03	5.0E-04	(1)	5.80E+00	4.64%
Chromium III	no	1.27E-02	1.0E+00	(1)	1.27E-02	0.01%
Chromium VI	no	2.11E-03	5.0E-03	(1)	4.22E-01	0.34%
Copper	no	3.88E-02	4.0E-02	(3,4)	9.70E-01	0.78%
Nickel	YES	3.42E-02	2.0E-02	(1)	1.71E+00	1.37%
Selenium	YES	8.40E-03	5.0E-03	(1)	1.68E+00	1.35%
Silver	no	2.30E-03	5.0E-03	(1)	4.60E-01	0.37%
Zinc	no	1.78E-01	3.0E-01	(1)	5.93E-01	0.48%
			TOTAL RISK FACTOR	=	1.25E+02	100%

NOTES:
(1) Toxicity values were obtained from IRIS (on-line July 28, 1995).
(2) Toxicity values were obtained from HEAST Annual FY-1994.
(3) Toxicity values were verified by teleconference on July 10, July 11, and August 2, 1995, with Marian Olsen, the USEPA Region II Risk Assessment Specialist, who spoke with the National Center for Environmental Assessment, Cincinnati, Ohio.
(4) The oral reference dose for copper is 4E-02 to 7E-02 mg/kg/day, a range based on nutritional safe levels and comparable to drinking water levels. Per Marian Olsen, the USEPA Region II Risk Assessment Specialist, the value noted in the table will provide conservatism in the risk assessment.

$$R_{ij} = (C_{ij})(T_{ij})$$

Where:

R_{ij} = risk factor for chemical I in medium j;

C_{ij} = concentration of chemical I in medium j; and

T_{ij} = toxicity value for chemical I in medium j;
(i.e., slope factor or 1/oral reference dose)

In accordance with RAGS and for conservatism, the maximum detected concentration of each chemical was used in the calculation (USEPA, 1989b). However, for samples having a duplicate analysis, the two values were averaged. Chemicals other than essential nutrients, which do not have established toxicity values (e.g., lead) could not be screened; however, they were not eliminated as chemicals of potential concern from the risk assessment for this reason. These chemicals were evaluated qualitatively as part of Section 4.3 and/or Appendix B. The chemical-specific risk factors for groundwater were summed to obtain a total risk factor for all chemicals. Separate total risk factors were calculated for carcinogens (using the appropriate slope factors) and noncarcinogens (using the appropriate oral reference doses). The ratio of the risk factor for each chemical detected in groundwater to the total risk factor for all chemicals detected in groundwater provided the relative contribution from each chemical detected in groundwater. A contribution of one (1) percent was used as a lower limit so that only the chemicals contributing at least 95 percent to the total risk were considered for further analysis in the risk assessment.

The potential toxicity of each chemical to human health was qualitatively evaluated based on a review of chronic noncarcinogenic effects, toxicity endpoint/target organ, potential carcinogenicity, and weight-of-evidence classification for potential carcinogenicity.

For the purposes of clarity, presented below is the USEPA's weight-of-evidence classification system for carcinogenicity (USEPA, 1986a and 1989b).

Group A:	Human Carcinogen
Group B1 or B2:	Probable Human Carcinogen B1 indicates that limited human data are available B2 indicates sufficient evidence in animals and inadequate or no evidence in humans
Group C:	Possible Human Carcinogen
Group D:	Not Classifiable as to human carcinogenicity
Group E:	Evidence of noncarcinogencity in humans

For the evaluation of chromium in this risk assessment, total chromium was speciated into its +3 and +6 valence states using a ratio of 6:1, respectively, per the IRIS data base (on-line July 1995). This ratio was assumed, as laboratory analysis for hexavalent chromium in groundwater is difficult to perform.

2.3.1 Blank Concentrations

As part of the data validation process, the chemicals detected in groundwater samples collected at the site were compared with chemicals detected in field and trip blanks to prevent the inclusion of non site-related chemicals in the risk assessment. The organic chemicals acetone, 2-butanone (methyl ethyl ketone), methylene chloride, toluene, and the phthalate esters are considered by the USEPA to be common laboratory contaminants (USEPA, 1989b).

Of the volatile organic chemicals of potential concern selected on-site groundwater (1,1-dichloroethene, tetrachloroethene, trichloroethene, and vinyl chloride), none were detected in blank samples.

SVOCs and pesticides/PCBs were not analyzed based on the results from on-site groundwater samples taken during the OU1 investigation.

Although only two inorganics, arsenic and selenium, were selected as chemicals of potential concern in site groundwater, antimony, cadmium, and nickel also show frequencies of detection

greater than five (5) percent and also contribute greater than one (1) percent to the total risk in the chemical concentration-toxicity screen. Of these five chemicals, antimony, cadmium, and nickel were detected in field blank samples. The site concentrations of these three chemicals were less than five times the concentration detection in field blanks specifically, antimony was detected in two field blanks at concentrations ranging from 21.1 B ug/l to 26.6 B ug/l. The maximum and only site groundwater detection of antimony is 25.0 B ug/l which is less than five times the maximum or minimum blank concentration. Although antimony was detected in only 1 of 18 samples (a frequency of detection of approximately 5.5 percent), it contributes 50 percent to the total risk for noncarcinogens in the groundwater chemical concentration-toxicity screen. Cadmium was detected in three field blanks at concentrations ranging from 2.2 B ug/l to 2.8 BJ ug/l. The maximum site groundwater detection of cadmium is 2.9 BJ ug/l which is less than five times the maximum or minimum blank concentration. Cadmium was detected in 5 of 18 samples (a frequency of detection of approximately 28 percent) and contributes nearly five percent to the total risk for noncarcinogens in the groundwater chemical concentration-toxicity screen. Nickel was detected in two field blanks at concentrations ranging from 13.2 B ug/l to 13.5 B ug/l. The maximum site groundwater detection of nickel is 34.2 B ug/l which is less than five times the maximum or minimum blank concentration. Nickel was detected in 9 of 18 samples (a frequency of detection of 50 percent), and contributes nearly 1.5 percent to the total risk for noncarcinogens in the groundwater chemical concentration-toxicity screen. Per discussions with the USEPA Remedial Project Manager (RPM) and Risk Assessment Specialist, antimony, cadmium, and nickel will not be quantitatively addressed in the risk assessment at this time. These inorganics are assessed qualitatively in Section 6.0, Uncertainties in Risk Assessment.

2.3.2 Background Concentrations

No background results are available for comparison to the on-site and off-site groundwater results used in the risk assessment. Blank concentrations, as discussed in the previous section (Section 2.3.1), were used instead for comparison to detected on-site and off-site concentrations to aid in determining the potential site-relatedness of detected chemical contaminants.

2.3.3 Physical and Chemical Properties

The chemicals detected in groundwater samples collected at and in the vicinity of the site can be classified into categories according to their similarity in chemical structure and/or physicochemical properties (factors which would influence mobility in the environment). The chemical categories and examples of chemicals detected at the site within each category are listed below:

- Chlorinated aliphatic compounds: dichlorodifluoromethane, 1,1-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, 1,2-dichloropropane, trichloroethene, 1,1,1-trichloroethane, tetrachloroethene, trichlorofluoromethane, vinyl chloride
- Aromatic compounds: benzene, chlorobenzene, toluene, m/p xylenes
- Inorganics (behaving as cations in water): antimony, barium, cadmium, trivalent chromium, copper, iron, lead, nickel, silver, zinc
- Inorganics (behaving as anions in water): arsenic, selenium

The physical and chemical properties that are important in determining a chemical contaminant's persistence and mobility in the environment were evaluated. The main properties that were reviewed were water solubility, K_{oc} (organic carbon partition coefficient), K_{ow} (octanol-water partition coefficient), volatilization, vapor pressure, vaporization, and Henry's law constant. This information is more difficult to evaluate for the inorganic chemicals because the migration of inorganics depends upon several site-specific factors such as the following:

- the presence of other cations and anions which can enhance or limit mobility by forming complexes
- pH differences between infiltrating precipitation, soil pore water, and aquifer materials
- the ability of the soil to retain metals through cation or anion exchange
- the presence of oxidizing or reducing agents

- the presence of humic materials or other organic chelating agents

The mobility of metals is therefore greatly dependent upon external factors which are seldom measured and cannot be easily determined based upon chemical-specific properties such as vapor pressure, solubility, and sorption to organic carbon. Moreover, physicochemical properties depend upon the identity of the metal complex which is almost never known (i.e., the analysis provides only information on total metal concentration, not on the metal complex or valence state).

The water solubility of a chemical is a critical property affecting its environmental fate. Chemicals with high water solubility can be rapidly leached from contaminated soil and are generally mobile in the groundwater. Solubilities can range from less than 1 mg/liter to totally miscible with most common organic chemicals falling between 1 mg/liter to 10^6 mg/liter (Lyman et al., 1982). The solubility of a chemical which is not readily soluble in water can become enhanced in the presence of other organic solvents which in and of themselves are more soluble in water.

The K_{oc} is used to reflect the potential of a chemical to sorb to the organic matter found in soil. The normal range of K_{oc} is 1 to 10^7, with higher values indicating greater sorption potential and lower values indicting limited retardation of a chemical. The octanol-water partition coefficient (K_{ow}) is used to estimate the extent to which a chemical will partition from water into lipophilic parts of organisms (i.e., animal fat). The greater the K_{ow}, the more likely a chemical is to partition to octanol (considered a surrogate for lipids).

Volatilization of a chemical is dependent on its vapor pressure, water solubility, and diffusion coefficients. Vapor pressure is a measure of the volatility of a chemical in its pure state. Vapor pressures typically range from 10^{-3} to 760 mm Hg for liquids, with solids ranging to less than 10^{-10}. Highly water soluble compounds generally have lower volatilization rates from water unless they also have high vapor pressures. Vaporization is also a major transport process. The rate of vaporization depends on temperature, degree of adsorption, soil properties, and soil water content.

Airflow over the evaporating surface also affects the rate of vaporization.

Henry's law constant, which combines vapor pressure with solubility and molecular weight, is more appropriate for estimating releases from water to air than the vapor pressure. Chemicals with Henry's law constants in the range of 10^{-3} and larger can be expected to be readily released to the atmosphere through volatilization. Chemicals with values ranging from 10^{-3} to 10^{-5} are associated with moderate volatilization, while chemicals with values less than 10^{-5} will only volatilize to a limited extent.

2.4 Evaluation of Tentatively Identified Compounds (TICs)

The RAGS document (USEPA, 1989b) specifies that both the identity and reported concentration of a TIC are questionable. The USEPA's Contract Laboratory Program (CLP) Routine Analytical Services (RAS) requires the contracted laboratory to analyze samples for organic chemicals on the TCL and for inorganic chemicals on the TAL. Chemicals on the TCL and TAL, however, may be a limited subset of the chemicals which may actually be encountered at the site. The analysis of VOCs and SVOCs may indicate the presence of additional organics not on the TCL. These additional chemicals appear as peaks on a chromatogram. A chromatogram is a paper representation of the response of the analytical instrument to the presence of a chemical. The laboratory attempts to identify the 30 highest peaks (10 VOCs and 20 SVOCs) using computerized searches of a library containing mass spectra (essentially "fingerprints" for particular chemicals). When the mass spectra match to a certain degree, the chemical or chemical class is named; however, the assigned identity is highly uncertain in most cases. These chemicals are therefore called TICs (USEPA, 1989b). Site Data (Appendix E) presents the TIC results. None of the TICs detected in groundwater have established toxicity values and therefore they have not been quantitatively addressed in this risk assessment.

2.5 Selected Chemicals of Potential Concern

Using the criteria discussed in Section 2.3, chemicals of potential concern were selected for groundwater. Table 2-3 presents the chemicals selected for quantitative evaluation in this risk assessment. As stated in Section 2.3.1., the inorganic chemicals antimony, cadmium, and nickel will be assessed quantitatively in Section 6.0, Uncertainties in the Risk Assessment.

TABLE 2-3

SYOSSETT LANDFILL OU 2
SUMMARY OF CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER

GROUNDWATER	
VOCs:	*Inorganics:*
1,1-Dichloroethene	Arsenic
Tetrachloroethene	Selenium
Trichloroethene	
Vinyl Chloride	

3.0 EXPOSURE ASSESSMENT

This section of the risk assessment presents the approach used for identifying the potential human exposure pathways at the Syosset Landfill site for potential future land use scenarios. The exposure pathways identified in this section are combined with chemical-specific toxicity data in Section 4.0 to characterize potential risks and health effects. All plausible exposures to receptor populations (i.e., residents, site workers, and industrial workers) associated with current and potential future site conditions have been considered. Future conditions are based on potential future uses of the site assuming no additional institutional controls are put in place and no remediation has occurred.

For potential future-use conditions, exposure scenarios which identify plausible routes of exposure to site-related chemical contaminants were developed. Exposure pathways were identified by assessing the various ways in which people living in the area and workers at the site could be exposed to chemicals originating from the site. The exposure point concentration of each chemical to which a person may be exposed via each pathway was estimated using the 95 percent UCL calculation. From the estimated exposure point concentrations, potential chemical intakes were calculated in terms of the mass of a substance ingested or inhaled per unit body weight per unit time, expressed as milligrams of a chemical per kilogram of body weight per day. Variables such as contact rate, exposure frequency, and exposure duration were considered in the calculation of the chemical intakes.

3.1 Potential Release and Transport Mechanisms

Chemical contaminants present in waste materials and contaminated source media may migrate through a number of release and transport mechanisms. In general, potential release and transport mechanisms may include:

- The leaching of chemical contaminants from subsurface soil into underlying

groundwater due to infiltration of precipitation.

- The volatilization of chemical contaminants present in groundwater into the ambient air.

3.2 Identification of Exposure Pathways

In accordance with RAGS (USEPA, 1989b), when determining the exposure pathways for a site two steps are followed. The initial step consists of characterizing the exposure setting. This step includes consideration of the physical characteristics of the site and potential future human receptors at or in the vicinity of the site (i.e., residents). Site characteristics may include climate and soil type (i.e., sandy). Potential human receptors such as site residents or workers may be observed with respect to activity patterns, presence of sensitive receptors (i.e., children, occupationally exposed individuals), and location. This step must also take into account the presence of potential future receptors under an alternate land use condition (i.e., zoning changes, currently unused water that is of potable quality for future-use).

The second step of exposure assessment involves identifying the appropriate exposure pathways for the site. As described in RAGS (USEPA, 1989b), an exposure pathway describes the course a chemical or physical agent takes from the source to the exposed individual. An exposure pathway analysis links the sources, locations, types of environmental releases, and environmental fate with receptor locations and activity patterns. An exposure pathway generally consists of four elements.

- A source and mechanism of release
- A transport medium
- An exposure point (point of potential contact with a contaminated medium)
- An exposure route (e.g., ingestion) at the exposure point

The following presents the basic analytical process for identifying and selecting exposure pathways in the risk assessment. An environmental medium contaminated by a previous release can be a contaminant source for other media. The identification of potential release mechanisms and receiving media may be determined utilizing site histories and data from existing reports. An example of a typical release source, mechanism of release, and receiving medium includes leaching from surface or buried wastes and contaminated soil into groundwater.

The fate and transport of the chemicals from release media are then considered in order to identify media that are receiving or may receive site-related chemicals. Points of potential contact with contaminated media (or sources) by human receptors are then considered. After exposure points are identified, potential exposure routes (i.e., ingestion, dermal contact, inhalation) may be selected.

By integrating the information presented above, complete and potentially complete exposure pathways at a site may be retained for quantitative evaluation in the risk assessment or eliminated from further analysis.

3.2.1 Present-Use Scenarios

As confirmed by the USEPA Risk Assessment Specialist, groundwater at the site is not currently being used as a source drinking water (Olsen, 1995). In addition, the Nassau County Public Health Ordinance for Private Drinking Systems (Article IV, Nassau County Department of Health) dated April 13, 1988 (Nassau County Department of Health, 1988) contains stringent policy regarding installation of private water system wells. Since contaminated groundwater at the site is not currently being used, all present-use exposure scenarios are incomplete. Therefore, present-use exposure scenarios have not been quantitatively addressed in this risk assessment.

3.2.2 Future-Use Scenarios

The potential exists, in the future, for further commercial or residential development of the Syosset Landfill site. Based on site history, discussions with the USEPA RPM and Risk Assessment Specialist, and on professional judgement, potential future-use exposure scenarios and human receptors were considered for quantitative evaluation. Table 3-1 presents the medium, receptors, and scenarios considered for analysis with a "yes" next to those selected and justification for the pathway's elimination from or retention for quantitative analysis.

The potential exists for future site area residents to obtain their potable water from wells installed into the chemically contaminated aquifer beneath the site. Residents may ingest the contaminated groundwater as well as inhale VOCs during such routine daily activities as cooking and showering.

Industrial worker and construction worker exposures are not being considered in the future-use scenario because it is highly unlikely that any new businesses will locate in this densely populated residential area. In addition, the Nassau County Public Health Ordinance for Private Drinking Systems (Article IV, Nassau County Department of Health) dated April 13, 1988 (Nassau County Department of Health, 1988) contains stringent policy regarding installation of private water system wells. Specifically, the Nassau Board of Health requires, insofar as possible, that all drinking water used by the public be provided by a public water system on the basis that such systems provide greater public health protection than that provided by a private water system.

3.3 Exposure Point Concentrations

Concentrations at potential exposure points (any point of potential contact with a contaminated medium) were developed individually for the chemicals of potential concern in groundwater for use in calculation of chronic daily intakes. This concentration is the 95 percent UCL on the arithmetic mean of the concentration that is contacted over the exposure period. Although this concentration does not reflect the maximum concentration that could be contacted at any one time

TABLE 3-1

SYOSSET LANDFILL SITE OU 2
POTENTIAL EXPOSURE PATHWAYS

Matrix	Receptor Population(s)	Exposure Route(s)	Retained for Quantitative Analysis	Justification
PRESENT-USE SCENARIOS:				
Groundwater				
	Area Residents (Adults and Children)	Ingestion	No	Since no area residents are using the aquifer beneath the site as a source of drinking water, no exposure to groundwater is occurring.
		Dermal Contact (Shower)	No	
		Inhalation of VOCs (Shower)	No	
	Industrial Workers	Ingestion	No	No industrial worker exposure to groundwater is occurring, since no industries in the area around the site are using the aquifer beneath the site as their source of drinking water.
		Dermal Contact (Shower)	No	
		Inhalation of VOCs (Shower)	No	
	Construction Workers	Ingestion	No	Since no construction work is currently in progress at or near the site, no construction worker exposure to groundwater is occurring.
		Dermal Contact (Shower)	No	
		Inhalation of VOCs (Shower)	No	
FUTURE-USE SCENARIOS:				
Groundwater				
	Site/Area Residents (Adults and Children)	Ingestion	Yes	The potential exists, if the site is residentially developed in the future, for site/area residents to obtain their potable water from wells installed into the aquifer beneath the site even though Nassau County has placed restrictions on the use of private water supply.
		Dermal Contact (Shower)	No*	
		Inhalation of VOCs (Shower)	Yes	
	Industrial Workers	Ingestion	No	Nassau County has enacted legislation that places restrictions on all new structures relative to private water supply. Also, it is highly unlikely that any business will locate to the small, densely populated residential area surrounding the site. Therefore, it is highly unlikely that there will be any future groundwater exposure to industrial workers.
		Dermal Contact (Shower)	No	
		Inhalation of VOCs (Shower)	No	
	Construction Workers	Ingestion	No	Nassau County has enacted legislation that places restrictions on all new structures relative to private water supply. Therefore, it is highly unlikely that construction workers will encounter any future exposure to groundwater.
		Dermal Contact (Shower)	No	
		Inhalation of VOCs (Shower)	No	

* The dermal contact with groundwater while showering pathway will be qualitatively addressed in the risk assessment.

it is considered a reasonable estimate of the concentration likely to be contacted over time, since long-term contact with the maximum concentration is not a reasonable assumption.

Due to the uncertainty associated with an estimate of exposure concentration, the 95 percent UCL on the arithmetic mean is used for this variable. If there is large variability in measured or modeled concentrations, the 95 percent UCL may exceed the maximum measured or modeled values, in which case, the maximum detected or modeled value is used. The formula used to calculate the 95 percent UCL for a lognormal distribution is as follows:

$$UCL = e^{(\bar{x} + 0.5s2 + sH/\sqrt{n-1})}$$

Where:

UCL	=	upper confidence limit
e	=	constant (base of the natural log, equal to 2.718)
x	=	mean of the transformed data
s	=	standard deviation of the transformed data
H	=	H-statistic (i.e., from table published in Gilbert, 1987)
n	=	number of samples

The lognormal distribution formula was selected based on an evaluation of the groundwater data (e.g., amount of data, number of detects). In calculating the 95 percent UCL value, non-detects were accounted for by using one-half the SQL as the proxy concentration. Appendix A presents the calculated 95 percent UCL concentrations used to estimate carcinogenic risks and noncarcinogenic hazards. All calculated 95 percent UCL concentrations were below the maximum detected site concentrations.

3.3.1 Exposure Point Concentration Modeling

In performing this risk assessment, modeling was required for the evaluation of inhalation exposure to VOCs in groundwater while showering. In this scenario, potential future human receptors were assumed to inhale VOCs while showering and during time spent in the bathroom after showering. Dermal absorption of volatilized VOCs and inorganics was assumed to be negligible. A chapter entitled *Estimating Dermal and Inhalation Exposure to Volatile Chemicals in Domestic Water* by J. Schaum et al. (1994) which appears as Chapter 13 in the recently published book entitled *Water Contamination and Health: Integration of Exposure Assessment, Toxicology, and Risk Assessment* was utilized to perform the shower modeling. This chapter presents a methodology for estimating exposure to VOCs in domestic water supplies for the inhalation and dermal contact exposure routes. The procedure for estimating exposure to VOCs was based on research performed by Julian Andelman (Andelman, 1990).

This model treats the bathroom as one compartment and yields an air concentration averaged over the time of the actual shower and the time spent in the bathroom after the shower. The model was derived by assuming that the chemical contaminant volatilizes at a constant rate, instantly mixes uniformly with the bathroom air, and that ventilation with clean air does not occur. This implies that the contaminant concentration in the air increases linearly from zero to a maximum at the end of the shower, and then remains constant during the time an individual spends in the bathroom immediately after the shower.

$$C(a) = \frac{[(C(aMAX)/2]\, t1 + C(aMAX)\, t2}{t1 + t2}$$

Where:

C(a)	=	concentration of chemical contaminant in air (mg/m^3)
C(aMAX)	=	maximum concentration of chemical contaminant in air (mg/m^3)
t1	=	time of shower (hr)
t2	=	time after shower (hr)

C(aMAX) is estimated as follows:

$$C(aMAX) = \frac{C(w)\ f\ F(w)\ t1}{V(a)}$$

Where:

C(aMAX)	=	maximum air concentration in bathroom (mg/m^3)
C(w)	=	water concentration (mg/l)
f	=	fraction volatilized (unitless)
F(w)	=	water flow rate (1/hr)
V(a)	=	bathroom volume (m^3)

The water concentration, C(w), is a site-specific value that refers to the concentration of a chemical in water as it enters the shower. The 95 percent UCL value, or the maximum detected value, was utilized as the water concentration.

The fraction volatilized, f, is a chemical-specific value that refers to the mass fraction of chemical in water that volatilizes over the course of the shower. Volatilization rates depend on properties such as Henry's law constants and molecular weights, although the relationship is not well established. Andelman (1990) has reported volatilization factors of 0.5 to 0.9 based on experiments with chloroform and trichloroethene. These chemicals have Henry's law constants of 2.87E-03 atm-m^3/mol and 9.10E-03 atm-m^3/mol, respectively, and are assumed to be representative of other VOCs. The fraction volatilized for all chemicals in the shower model was assumed to be 75 percent, based on the assumptions used in the model.

The water flow rate, F(w), refers to the rate at which water flows into the shower. A value of 750 l/hr was assumed in the model.

The bathroom volume, V(a), refers to the volume of the bathroom including the shower stall. A value of 12 m^3 was assumed in the model.

The shower time, t1, refers to the actual time of the shower. A 90th percentile value of 12 minutes

(0.2 hr) (USEPA, 1989b) was assumed in the model.

The time spent in the bathroom after showering, t2, was assumed to be 20 minutes (0.3 hr). The variables selected for input into the shower model generally represent average values in an attempt to reduce over conservatism inherent in the model.

The model is very conservative in nature due to the combination of the following assumptions:

- constant volatilization
- no ventilation
- the concentration of the chemical contaminant is assumed to be zero at the start of the shower (i.e., no residual chemical concentrations remain from previous showers taken by other family members or from other water use activities)
- the exchange between air in the shower chamber and bathroom air is so rapid that the combined volume of the two compartments can be treated as a single chamber with a single concentration of volatilized chemical (i.e., all persons in the bathroom are instantly exposed to the same chemical concentrations), and
- the model does not account for the exchange rate that occurs when an exhaust fan is turned on

Since groundwater at the site has been found to contain VOC contamination and the potential exists in the future for the groundwater to be used as a potable source, it has been evaluated for potential health impacts.

3.4 Calculation of Chronic Daily Intakes

To quantitatively assess the potential carcinogenic risks and health hazards to human populations based on the potential future-use scenarios discussed in Section 3.2, daily intakes were calculated. These daily intakes were evaluated for chronic exposures (USEPA, 1989b).

For the chronic daily intakes, intakes were averaged over a lifetime for carcinogenic chemicals and over the period of exposure for noncarcinogens. The daily intake was expressed in terms of

the mass of the chemical per unit of body weight over the averaging time (mg chemical/kg body weight-day).

Equations presented and described in RAGS (USEPA, 1989b) were used to estimate daily intakes from ingestion and inhalation of VOC exposures. These equations are presented in Tables 3-2 and 3-3 and also appear at the top of the appropriate spreadsheets for clarity.

3.5 Groundwater Exposure Assumptions

All exposure parameters selected for use in the chronic daily intake calculations are presented in Table 3-4. The following sections describe the reasoning behind their selection and the sources from which the values were obtained. Daily intakes were calculated for residents (adults and children) only. Children have been identified as a subpopulation that is potentially at higher risk from chemical exposure due to increased sensitivity.

For all receptor populations, the chemical concentrations in the groundwater (except for chemical concentrations in the shower model) were based on actual site data from which 95 percent UCLs were calculated.

All child exposures to noncarcinogens are considered chronic in duration per USEPA direction since the exposure duration (6 years) is at the upper-bounds of subchronic exposure.

TABLE 3-2

SYOSSET LANDFILL SITE
INGESTION OF CHEMICALS IN DRINKING WATER

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

Where:

CW	=	Chemical Concentration in Water (mg/liter)
IR	=	Ingestion Rate (liters/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (period over which exposure is averaged - days) (For carcinogens, AT is lifetime; for noncarcinogens, AT = ED x 365 days/year)

TABLE 3-3

SYOSSET LANDFILL SITE
INHALATION OF AIRBORNE CHEMICALS
(SHOWER SCENARIO)*

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AT}$$

Where:

CA	=	Chemical Concentration in Air (mg/m^3)
IR	=	Inhalation Rate (m^3/hour)
ET	=	Exposure Time (hours/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
BW	=	Body Weight (kg)
AT	=	Averaging Time (period over which exposure is averaged - days) (For carcinogens, AT is lifetime; for noncarcinogens, AT = ED x 365 days/year)

*Schaum et al. (1994) based on the Andelman (1990) Shower Model

TABLE 3-4

SYOSSET LANDFILL SITE OU 2
VARIABLES USED FOR CHRONIC DAILY INTAKE CALCULATIONS

		CONCENTRATIONS		CONTACT PARAMETERS	TIME VARIABLES				
Matrices and Receptor Populations	Exposure Route	CW (mg/l)	CA (mg/m3)	IR (1) (variable)	ET (hr/day)	EF (days/yr)	ED (yrs)	AT (2) (years)	BW (kg)
Groundwater									
Site/Area Residents									
Adults	Ingestion	Site Data	-	2 l/day	-	350	24	70(24)	70
Children (0-6 years old)	Ingestion	Site Data	-	1 l/day	-	350	6	70(6)	15
Adults	Inhalation (Shower)	-	(3)	0.6 m3/hr	0.5	350	24	70(24)	70
Children (0-6 years old)	Inhalation (Shower)	-	(3)	0.6 m3/hr	0.5	350	6	70(6)	15

NOTES:
(1) Ingestion or inhalation rate.
(2) 70 years for carcinogens, 24 years for noncarcinogens for adult residents, and 6 years for noncarcinogens for children (multiplied by 365 days).
(3) This value will be modeled using Schaum et al. (1994) based on the Andelman (1990) Shower Model.

Other Abbreviations:

CW = Chemical concentration in water
CA = Chemical concentration in air
ET = Exposure Time
EF = Exposure Frequency
ED = Exposure Duration
BW = Body Weight
AT = Averaging Time

Residents: For potential future residential groundwater exposure, site sample data were used to calculate chemical concentrations for use in the intake equations.

Ingestion rates (IR) of 2 liters/day for adults and 1 liter/day for children potentially living at or near the site (residents) in the future were assumed based on information presented in a USEPA guidance document USEPA (1989c). The 2 liters/day adult ingestion rate represents an historical long-term average consumption rate and includes drinking water consumed in the form of beverages (i.e., juices containing tap water). The 1 liter/day child ingestion rate is assumed to be protective of this sensitive receptor, who is also expected to ingest beverages other than those containing water. An exposure frequency (EF) of 350 days/year was assumed based on the assumption that 2 weeks/year are spent away from home on vacation (USEPA, 1991a). The exposure duration (ED) was assumed to be 24 years for adults and 6 years for children (USEPA, 1989b). The thirty year total corresponds to the national upper-bound (90^{th} percentile) time spent at one residence. The averaging time (AT) was calculated as the exposure duration (24 years for adults and 6 years for children) multiplied by 365 days/year for noncarcinogens, and 70 years (lifetime) for adults and children multiplied by 365 days/year for carcinogens (USEPA, 1989b). Body weights (BW) of 70 kg for adults and 15 kg for children were assumed (USEPA, 1991a).

For residential inhalation of VOCs during showering, the Andelman (1990) shower model was run utilizing the procedures discussed in Schaum et al. (1994). The details of the model are presented in Section 3.3.1. Using the two equations presented, the average concentration of a volatile chemical in the shower air over the period of time spent in the shower was calculated. This value was then used in the intake calculation. An inhalation rate (IR) of 0.6 m^3/hour was assumed based on information presented in USEPA (1989b). This value assumes that showering represents light activity and is representative of the entire exposed population (USEPA, 1989b, 1989c). An exposure time (ET) of 0.5 hour/day (30 minutes) was assumed based on the time of the shower (0.2 hour/day or 12 minutes) which is the 90^{th} percentile value specified in USEPA (1989b) and the time spent in the bathroom after showering (0.3 hour/day or 18 minutes). The exposure frequency (EF), exposure duration (ED), averaging time (AT), and body weights (BW) are the same as residential ingestion exposure.

4.0 TOXICITY ASSESSMENT

The toxicity assessment presents the general toxicological properties of the selected chemicals of potential concern using the most current toxicological human health effects data. Toxicity profiles for each of the chemicals of potential concern are presented in Appendix B.

Each chemical can produce a wide variety of human health effects. While only certain chemicals can produce potentially carcinogenic effects, all chemicals have the potential to produce noncarcinogenic effects, depending on the type and duration of exposure. The USEPA has developed a qualitative weight-of-evidence classification system in which available data for a chemical are evaluated to determine the likelihood that the agent is a human carcinogen. Evidence is characterized separately for human and animal studies as sufficient, limited, or inadequate evidence, no data, or evidence of no effect. The characterizations of these two types of data are combined and the chemical is given a provisional weight-of-evidence classification based on the extent to which the agent has been shown to be carcinogenic in experimental animals, humans, or both. Supporting evidence of carcinogenicity may adjust the provisional weight-of-evidence classification up or down. The USEPA weight-of-evidence classification system for carcinogenicity, as discussed in Section 2.3, is described again below for the purposes of clarity.

GROUP	DESCRIPTION
A	Human Carcinogen.
B1	Probable Human Carcinogen. Limited human data are available.
B2	Probable Human Carcinogen. Sufficient evidence of carcinogenicity in animals and inadequate or no evidence in humans.
C	Possible Human Carcinogen.
D	Not Classifiable as to human carcinogenicity.
E	Evidence of noncarcinogenicity for humans.

Two measurements used to quantify the toxic effects of a chemical on human health include a chemical's carcinogenic slope factor (SF) and noncarcinogenic reference dose (RfD). Many of

the carcinogenic slope factors and reference doses (including reference concentrations which are often converted to references doses) used in this assessment were obtained from USEPA's IRIS data base. IRIS is an on-line data base which is updated monthly. It provides chemical-specific risk data that represents a USEPA scientific consensus. The quantitative risk values and supporting explanations in IRIS have been reviewed and agreed upon by scientists across the USEPA using available studies on a chemical.

Slope factors and reference doses/concentrations not available on IRIS were obtained from the USEPA's second most current source of toxicity information, the HEAST FY 1994-Annual (USEPA, 1994). The HEAST is a comprehensive listing consisting almost entirely of provisional risk assessment information relative to oral and inhalation routes for chemicals. The entries in the HEAST are limited to chemicals that have undergone some form of agency review, but have not been sufficiently reviewed to be recognized as high quality, Agency-wide consensus information. These entries, therefore do not appear on the IRIS system. When no values were located in either IRIS or HEAST, the USEPA Region II Risk Assessment Specialist consulted with the USEPA National Center for Environmental Assessment in Cincinnati, Ohio.

4.1 Health Effects Criteria for Carcinogens

Generally, a slope factor is a plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. In risk assessment, a slope factor is used to estimate an upper-bound probability of an individual developing cancer as a result of exposures to carcinogenic chemicals over various exposure periods. Slope factors are verified by the USEPA's Carcinogen Risk Assessment Verification Endeavor (CRAVE) Workgroup. Table 4-1 presents slope factors for the potentially carcinogenic chemicals of potential concern. Oral and inhalation unit risk estimates were converted to slope factors, per the HEAST and USEPA Region II guidance, by multiplying by 70 kg (assumed human body weight), dividing by 20 m^3/day (assumed human inhalation rate) or by 2 liters/day (assumed human water consumption rate) and multiplying by 1000 ug/mg (conversion factor). The slope factor, which is usually the upper 95th

8/2/95
TOXNOS.XLS

TABLE 4-1

SYOSSET LANDFILL SITE OU 2
TOXICITY VALUES FOR POTENTIAL CARCINOGENIC HEALTH EFFECTS
DOSE - RESPONSE RELATIONSHIP

CHEMICALS	CARCINOGENS: SLOPE FACTORS (SF)		
	Oral SF (mg/kg-day)-1	Inhalation SF (mg/kg-day)-1	Weight - of - Evidence
Volatile Organics			
Benzene	2.9E-02 (1)	2.9E-02 (2)	A
Chlorobenzene	-	-	D
Dichlorodifluoromethane	-	-	-
1,1-Dichloroethane	-	-	C
1,1-Dichloroethene	6.0E-01 (1)	1.2E+00 (1)	C
cis-1,2-Dichloroethene	-	-	D
1,2-Dichloropropane	6.8E-02 (2)	-	B2
Tetrachloroethene	5.2E-02 (3)	2.0E-03 (3)	B2-C
Toluene	-	-	D
1,1,1-Trichloroethane	-	-	D
Trichloroethene	1.1E-02 (4)	6.0E-03 (3)	B2-C
Trichlorofluoromethane	-	-	-
Vinyl Chloride	1.9E+00 (2)	3.0E-01 (2)	A
m/p Xylenes	-	-	D
Inorganics			
Antimony	-	-	-
Arsenic	1.5E+00 (1)	5.0E+01 (2)	A
Barium	-	-	-
Cadmium	-	6.3E+00 (1)	B1
Chromium III	-	-	-
Chromium VI	-	4.1E+01 (2)	A
Copper	-	-	-
Lead (and compounds-inorg.)	-	-	B2
Nickel (sol. salt)	-	-	-
Selenium	-	-	D
Silver	-	-	D
Zinc (and compounds)	-	-	D

TABLE 4-1 (Cont'd)

NOTES:

- Iron, potassium, and sodium are considered essential nutrients and will not be quantitatively evaluated in the risk assessment.
(1)Toxicity values were obtained from IRIS (on-line July 28, 1995).
(2) Toxicity values were obtained from HEAST Annual FY-1994.
(3) Toxicity values were verified by Marian Olsen, the USEPA Region II Risk Assessment Specialist, who consulted the National Center for Environmental Assessment on July 31, 1995.
(4) Toxicity value was verified by the Superfund Health Risk Technical Support Center (now known as the National Center for Environmental Assessment) on October 27, 1994 and was confirmed by Marian Olsen, the USEPA Region II Risk Assessment Specialist, on July 10, 1995.

USEPA WEIGHT - OF - EVIDENCE:

A - Human Carcinogen
B1 - Probable Human Carcinogen. Limited human data are available.
B2 - Probable Human Carcinogen. Sufficient evidence of carcinogenicity in animals and inadequate or no evidence in humans.
C - Possible Human Carcinogen
D - Not Classifiable as to human carcinogenicity.
E - Evidence of noncarcinogenicity for humans.

percent confidence limit of the slope of the dose-response curve, is expressed in $(mg/kg\text{-}day)^{-1}$. It represents the probability of an individual developing cancer as a result of chronic exposure to a given carcinogenic chemical over a specified exposure period. A risk of 10^{-6} indicates that the probability of an individual developing cancer from a given exposure is unlikely to exceed 1 in 1,000,000.

4.2 Health Effects Criteria for Noncarcinogens

The determination of the potential for health hazards associated with exposure to noncarcinogens was made by comparing the estimated chronic daily intake of a chemical with the reference dose.

Various reference doses are available depending on the exposure route, the critical effect, and the length of exposure evaluated in the scenario. For this assessment, chronic oral and inhalation reference doses (RfDs) were used. It should be noted that inhalation RfDs were developed by converting a Reference Concentration in air (mg/m^3) to a corresponding inhaled dose (mg/kg-day) by dividing by 70 kg (assumed human body weight) and multiplying by 20 m^3/day (assumed human inhalation rate) per the HEAST and USEPA Region II direction. Table 4-2 presents these values along with their uncertainty factors.

A chronic reference dose is defined as an estimate (with uncertainty spanning possibly an order of magnitude or greater) of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime. The chronic reference doses derived by the USEPA's Reference Dose Reference Concentration Workgroup are specifically developed to be protective for long-term exposure to a chemical. In this risk assessment, exposures of six years and greater were considered chronic. Since the USEPA considers a six year exposure to be the upper-bounds of subchronic exposure, chronic toxicity values are more appropriately used.

For many noncarcinogenic effects, it is believed that protective mechanisms exist which must be

8/2/95
TOXNOS-2.xls

TABLE 4-2

SYOSSET LANDFILL SITE
CHRONIC TOXICITY VALUES FOR POTENTIAL NONCARCINOGENIC HEALTH EFFECTS
DOSE - RESPONSE RELATIONSHIP

CHEMICALS	NONCARCINOGENS: REFERENCE DOSES (RfD)			
	Oral RfD (mg/kg-day)	Uncertainty Factor	Inhalation RfD (mg/kg-day)	Uncertainty Factor
Volatile Organics				
Benzene	-	-	1.7E-03 (3)	1000
Chlorobenzene	2.0E-02 (1)	1000	5.7E-03 (2)	10000
Dichlorodifluoromethane	2.0E-01 (1)	100	5.7E-02 (3)	10000
1,1-Dichloroethane	1.0E-01 (2)	1000	1.4E-01 (3)	1000
1,1-Dichloroethene	9.0E-03 (1)	1000	-	-
cis-1,2-Dichloroethene	1.0E-02 (2)	3000	-	-
1,2-Dichloropropane	-	-	1.1E-03 (1)	300
Tetrachloroethene	1.0E-02 (1)	1000	-	-
Toluene	2.0E-01 (1)	1000	1.1E-01 (5)	300
1,1,1-Trichloroethane	-	-	2.9E-01 (3)	1000
Trichloroethene	6.0E-03 (3)	3000	-	-
Trichlorofluoromethane	3.0E-01 (1)	1000	2.0E-01 (2)	10000
Vinyl Chloride	-	-	-	-
m/p-Xylenes	2.0E+00 (3)	100	-	-
Inorganics				
Antimony	4.0E-04 (1)	1000	-	-
Arsenic	3.0E-04 (1)	3	-	-
Barium	7.0E-02 (1)	3	1.4E-04 (3)	1000
Cadmium	5.0E-04 (1)	10	-	-
Chromium III	1.0E+00 (1)	100	-	-
Chromium VI	5.0E-03 (1)	500	-	-
Copper	4.0E-02 (3,4)	-	-	-
Lead (and compounds-inorg.)	-	-	-	-
Nickel (sol. salt)	2.0E-02 (1)	300	-	-
Selenium	5.0E-03 (1)	3	-	-
Silver	5.0E-03 (1)	3	-	-
Zinc (and compounds)	3.0E-01 (1)	3	-	-

TABLE 4-2 (Cont'd)

NOTES:

- Iron, potassium, and sodium are considered essential nutrients and will not be quantitatively evaluated in the risk assessment.
(1) Toxicity values were obtained from IRIS (on-line July 28, 1995).
(2) Toxicity values were obtained from Heast Annual FY-1994.
(3) Toxicity values were verified by teleconference on July 10, July 11, and August 2, 1995, with Marian Olsen, the USEPA Region II Risk Assessment Specialist, who spoke with the National Center for Environmental Assessment, Cincinnati, Ohio.
(4) The oral reference dose for copper is 4E-02 to 7E-02 mg/kg/day, a range based on nutritional safe levels and comparable to drinking water levels. Per Marian Olsen, the USEPA Region II Risk Assessment Specialist, the value noted in the table will provide conservatism in the risk assessment.
(5) Toxicity value was obtained from IRIS (on-line July 11, 1995).

overcome before an adverse effect is manifested. For example, when a large number of cells perform the same or similar function, a significant number of the cells may have to be depleted before an effect is seen. Therefore, there is a range of exposures between zero and some finite value that can be tolerated by the organism with essentially no chance of expression of adverse effects.

Oral and inhalation chronic reference doses are derived from the no-observed-adverse-effect-level (NOAEL) or the lowest-observed-adverse-effect-level (LOAEL) for the critical toxic effect by application of uncertainty factors (UFs) and a modifying factor (MF-oral only). Uncertainty factors ranging from 1 to 10 are assigned to reflect extrapolation from animals to humans; sensitive animals; LOAEL to NOAEL; and subchronic to chronic. Most commonly, the Uncertainty Factor used is 10. Modifying Factors range from 1 to 10 reflecting the completeness of the scientific database for the chemicals.

Uncertainty related to toxicity information will be discussed in Section 6.0 Uncertainties in Risk Assessment.

4.3 Qualitative Discussion of Chemicals Not Quantitatively Evaluated in the Risk Assessment

Iron and lead (besides the essential nutrients) could not be quantitatively evaluated in this risk assessment due to the lack of established toxicity values. Antimony, nickel and cadmium were addressed qualitatively in this risk assessment because of field blank contamination associated with these chemicals. This section presents brief toxicological profiles for these chemicals, as well as for chromium (III). Full toxicological profiles for these chemicals, with the exception of iron, are provided in Appendix B.

antimony - Antimony production has been associated with an increase in lung cancer in exposed workers. An inhalation study using rats yielded suggestive evidence that antimony trioxide causes lung and liver tumors, and several antimony compounds were mutagenic when tested using

bacterial test systems. Female workers exposed to antimony compounds had an increased incidence of gynecological disorders and spontaneous abortions; similar effects were observed in an animal study. Antimony also causes cardiovascular changes in humans and may damage the myocardia (Clement Associates, Inc., 1985).

cadmium - Chronic oral or inhalation exposure of humans to cadmium has been associated with renal dysfunction, itai-itai disease (bone damage), hypertension, anemia, endocrine alterations, and immunosuppression. Renal toxicity occurs in humans at a renal cortex concentration of cadmium of 200 ug/g. Epidemiological studies have demonstrated a strong association between inhalation exposure to cadmium and cancers of the lungs, kidney, and prostate (USEPA, 1985).

chromium (III) - As requested by the USEPA Region II Risk Assessment Specialist, a discussion regarding the toxicity of chromium (III) and chromium (VI) is included in this risk assessment. Chromium, an essential micronutrient, can produce kidney and liver damage following acute oral exposures (USEPA, 1984). Chronic inhalation exposures may cause respiratory system damage (USEPA, 1984). The USEPA has classified inhaled chromium (VI) for carcinogenicity in Group A (Human Carcinogen) (IRIS, 1995). Inhaled chromium (III) and ingested chromium (III) and (VI) have not been classified with respect to carcinogenicity.

iron - This chemical is an essential element (Amdur et al., 1986). The ingestion of excessive amounts of this chemical can irritate the gastrointestinal tract. Inhaling some iron containing dusts and fumes can cause siderosis, a type of benign pneumoconiosis (Clement Associates, Inc., 1985).

lead - A full toxicological profile for this chemical is located in Appendix B Toxicological Profiles due to the extensive amount of information available and its Group B2 weight-of-evidence classification.

nickel - Nickel compounds can be absorbed following inhalation, ingestion, or dermal exposure. The amount depends on the dose administered and the chemical and physical form or the particular

nickel compound. Chronic or subchronic exposure of experimental animals to nickel has been associated with reduced weight gain, degenerative lesions of the male reproductive tract, asthma, nasal septal perforations, rhinitis, sinusitis, hyperglycemia, decreased prolactin levels, decreased iodine uptake, and vasoconstriction of the coronary vessels. Inhalation exposure of experimental animals to nickel carbonyl or nickel subsulfate induces pulmonary tumors (USEPA, 1986c). A full toxicological profile for this compound is located in Appendix B Toxicological Profiles.

The inability to quantitatively evaluate these chemicals (and other essential nutrients) is a source of uncertainty in this risk assessment as the potential for underestimation of risks or health impacts exists. Uncertainty related to chemical toxicity data is addressed further in Section 6.0 Uncertainties in Risk Assessment.

5.0 RISK CHARACTERIZATION

The characterization of potential carcinogenic risks and noncarcinogenic health effects estimates associated with the "no action" alternative were evaluated for the exposure pathways identified in Section 3.2. The spreadsheet calculations which present quantitative estimates of carcinogenic risks and noncarcinogenic health effects are presented in Appendix C. Applicable or Relevant and Appropriate Requirements (ARARs) are discussed for those chemicals contributing the greatest amount to carcinogenic risks and noncarcinogenic hazard index values in groundwater (i.e., chemicals of potential concern).

5.1 Carcinogenic Risk Characterization

For carcinogens, risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen (i.e., incremental or excess individual lifetime cancer risk).

Per RAGS (USEPA, 1989b), the slope factor converts estimated daily intakes averaged over a lifetime of exposure directly to incremental risk of an individual developing cancer. Since the slope factor is often an upper 95th percentile confidence limit of the probability of response based on experimental animal data used in the multistage model, the carcinogenic risk estimate will generally be an upper-bound estimate. This means that the USEPA is reasonably confident that the "true risk" will not exceed the risk estimate derived through use of this model and is likely to be less than that predicted. Since relatively low intakes (in comparison to those experienced by test animals) are most likely from environmental exposures at Superfund sites, the USEPA assumes that the dose-response relationship is linear in the low dose portion of the multistage model dose-response curve. Under this assumption, the slope factor is constant and risk will be directly related to intake. Therefore, the linear form of the carcinogenic risk equation, as presented below, was used to estimate risk.

$$Risk = CDI \times SF$$

Where:

Risk = a unitless probability of an individual developing cancer;

CDI = chronic daily intake averaged over 70 years (mg/kg-day);

SF = slope factor expressed in $(mg/kg\text{-}day)^{-1}$

5.2 Noncarcinogenic Effects Characterization

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period with a reference dose derived for a similar exposure period. This ratio of exposure to toxicity is referred to as a hazard quotient; the sum of the individual hazard quotients is referred to as a hazard index. The formula for the hazard index is presented below.

$$\text{Noncancer Hazard Index} = E_1/RfD_1 + E_2/RfD_2 + E_i/RfD_i$$

Where:

E = Exposure Intake (chronic) for the i^{th} chemical
RfD = Reference Dose (chronic) for the i^{th} chemical

The noncancer hazard quotient assumes that there is a level of exposure (i.e., RfD) below which it is unlikely even for sensitive populations to experience adverse health effects. If the exposure intake exceeds the threshold (i.e., the noncancer hazard quotient exceeds 1), there may be concern for potential noncancer effects. Generally, the greater the value of the noncancer hazard quotient above 1, the greater the level of concern. However, the ratio should not be interpreted as a statistical probability. It is important to note that the level of concern does not increase linearly as the RfD is approached or exceeded, as RfDs do not have equal accuracy or precision and are not based on the same severity of toxic effects.

If the hazard index exceeds 1 due to the summing of several hazard quotients, segregation of the hazard index by critical effect or mechanism is performed.

5.3 Quantitative Results of Carcinogenic Risk and Noncarcinogenic Effects Evaluation for Groundwater

In accordance with the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) Section 300.430(e)(2) for known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper-bound lifetime cancer risk to an individual in the range of 10^{-4} to10^{-6}. Per RAGS Part B: Development of Risk-Based Preliminary Remediation Goals (USEPA, 1991b), for noncarcinogenic effects, the NCP implies a hazard index of 1.

In general, the USEPA recommends target ranges or values (i.e., risk = 10^{-4} to 10^{-6} or hazard index = 1) as threshold values for potential human health impacts (USEPA, 1989b). A risk or hazard index greater than this is considered to be in exceedance of the USEPA's target risk range or target value. These values aid in determining the objectives of the baseline human health risk assessment which include determining whether additional response action is necessary at the site, by providing a basis for determining residual chemical levels that are adequately protective of human health, by providing a basis for comparing potential health impacts of various remedial alternatives, and to help support selection of the "no action" remedial alternative, where appropriate.

The results of carcinogenic risk and noncarcinogenic hazard index calculations for potential future residential (adult and child) exposures to groundwater via the ingestion and inhalation routes are presented in Tables C-1 and C-2 of Appendix C.

Site/Area Residents: Table C-1, potential future residential groundwater ingestion, shows total carcinogenic risks for adults and children of 1.5E-04 and 8.5E-05, respectively. The adult risk falls within the upper-bound of the USEPA's 10^{-4} to 10^{-6} target risk range and is due almost

entirely to 1,1-dichloroethene, tetrachloroethene, vinyl chloride, and arsenic which show individual risks of 2.5E-05, 2.9E-05, 5.4E-05, and 3.8E-05, respectively. The child risk falls below the upper-bounds of the target risk range. The 30-year combined risk for adults and children, 2.3E-04, falls within the upper-bounds of the USEPA's 10^{-4} to 10^{-6} target risk range and is due almost entirely to 1,1-dichloroethene, tetrachloroethene, vinyl chloride, and arsenic.

The hazard index values for adult and child groundwater ingestion are 4.5E-01 and 1.0E+00, respectively. These values do not exceed the USEPA's target level of 1 for noncarcinogens.

Table C-2, potential future residential inhalation of VOCs in groundwater during and after showering (shower model), shows total carcinogenic risks for adults and children of 6.7E-05 and 7.8E-05, respectively. These risks fall below the upper-bounds of the USEPA's target risk range. The 30-year combined risk for adults and children, 1.5E-04, falls within the upper-bounds of the 10^{-4} to 10^{-6} target risk range and is due almost entirely to 1,1-dichloroethene, tetrachloroethene, and vinyl chloride.

The hazard index values for potential future adult and child inhalation of VOCs in groundwater during and after showering (shower model) could not be calculated as none of the chemicals of potential concern have established inhalation reference doses.

5.4 Combining Cancer Risks and Noncancer Hazard Index Values Across Exposure Pathways

Multichemical cancer risk/noncancer hazard estimates may be combined across exposure pathways for exposed receptor group(s) provided that the same group(s) would consistently face the RME by more than one pathway. Cancer risks from various exposure pathways are assumed to be additive, as long as the risks are for the same individuals and time period. For noncarcinogens, the total hazard index values for each exposure duration were calculated separately.

The summing of appropriate carcinogenic risks and noncarcinogenic hazard index values is presented in Tables 5-1 and 5-2, respectively. The total carcinogenic risks for adults and children fall within the upper-bounds of the USEPA's 10^{-4} to 10^{-6} target risk range. The total hazard index values for adults and children do not exceed the USEPA's target level of one.

5.5 Applicable or Relevant and Appropriate Requirements (ARARs)

The National Contingency Plan (NCP) and Section 121(d) of CERCLA (cleanup standards) requires that the selected remedial actions at Superfund sites attain or exceed applicable or relevant and appropriate requirements (ARARs) of federal laws and more stringent promulgated state laws.

ARARs are identified to determine media and chemical contaminants that may require remediation and regulations that may apply to remedial action.

A requirement under CERCLA and under other environmental laws may be either "applicable" or "relevant and appropriate" to a remedial action, but not both. A two-tiered approach may be applied: first, to determine whether a given requirement is applicable, then, if it is not applicable, to determine whether it is relevant and appropriate. These terms are defined in the NCP as follows:

- Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable. Examples of applicable requirements are maximum contaminant levels (MCLs) promulgated under the Safe Drinking Water Act for contamination of a drinking water supply aquifer.

- Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria or limitations described above, that, while not "applicable", address problems or situations sufficiently similar to

8/2/95
PWAYADD.XLS

TABLE 5-1

SYOSSET LANDFILL SITE OU 2
COMBINING CARCINOGENIC RISKS ACROSS PATHWAYS

MEDIA	RECEPTOR POPULATION	EXPOSURE ROUTE	INDIVIDUAL CANCER RISK	CHEMICALS CONTRIBUTING THE GREATEST AMOUNT TO RISK
GROUNDWATER				
	Residents:			
	Adults	Ingestion	1.5E-04	(2)
		Inhalation of VOCs (Shower)	6.7E-05	(1)
		Total Carcinogenic Risk =	2.2E-04	(2)
	Children (0-6 years old)	Ingestion	8.5E-05	(1)
		Inhalation of VOCs (Shower)	7.8E-05	(1)
		Total Carcinogenic Risk =	1.6E-04	(2)
		Total Carcinogenic Risk = (Adult and Child)	3.8E-04	(2)

Notes

(1) Indicates that the carcinogenic risk falls below the upper-bounds of the target risk range; therefore, no chemicals were selected as contributors.
(2) Indicates that even though the carcinogenic risk falls within the upper-bounds of the target risk range, all chemicals show individual risks below the upper-bounds of the target risk range.

7/17/95
PWAYADDNC.XLS

TABLE 5-2

SYOSSET LANDFILL SITE OU 2
COMBINING NONCARCINOGENIC HAZARD INDEX VALUES ACROSS PATHWAYS

MEDIA	RECEPTOR POPULATION	EXPOSURE ROUTE	INDIVIDUAL HAZARD INDEX	CHEMICALS CONTRIBUTING THE GREATEST AMOUNT TO HAZARD INDEX VALUES
GROUNDWATER				
	Residents:			
	Adults	Ingestion	4.5E-01	(1)
		Inhalation of VOCs (Shower)	NA	(1)
		Total Hazard Index =	4.5E-01	(1)
	Children (0-6 years old)	Ingestion	1.0E+00	(1)
		Inhalation of VOCs (Shower)	NA	(1)
		Total Hazard Index =	1.0E+00	(1)

Notes

NA: Not Available (could not be calculated).

(1) Indicates that the noncarcinogenic hazard index does not exceed the target level of 1 or could not be calculated; therefore, no chemicals were selected as contributors.

those encountered at a CERCLA site that their use is well-suited to the particular site.

- Other requirements to be considered (TBCs) are non-promulgated federal and state advisories or guidance documents. These do not have status as potential ARARs; however, these advisories or guidance documents may be considered in determining the necessary level of cleanup for the protection of health or the environment.

The USEPA divides ARARs into 3 categories: chemical-specific, location-specific, and action-specific. This distinction is based on whether the requirement is triggered by the presence or emission of a chemical, by a sensitive or protected location, or by a particular remedial action, respectively.

Chemical-specific ARARs are useful in identifying chemicals that may pose a risk and require remediation, and may be selected as cleanup levels that must be achieved by a particular action. Chemical-specific requirements set concentration limits or ranges in various environmental media for specific hazardous substances, pollutants or contaminants. These requirements (i.e., MCLs) may represent protective levels for designated media.

USEPA Region II federal and state MCLs have been identified in this risk assessment for the selected chemicals of potential concern in site groundwater (see Table 2-3). These MCLs were obtained from the Region II Drinking and Groundwater Standards Update (USEPA, 1993). Table 5-3 presents the MCLs along with the range of detected concentrations of chemicals of potential concern for comparative purposes.

For the VOCs in Table 5-3, each maximum site concentration exceeds its established MCL(s). For the inorganics in Table 5-3, the maximum site concentrations of arsenic and selenium do not exceed their established MCLs.

08/02/95
MCL.XLS

TABLE 5-3

SYOSSET LANDFILL SITE OU 2
DETECTED CONCENTRATIONS VERSUS MAXIMUM CONTAMINANT LEVELS (MCLs) FOR
CHEMICALS OF POTENTIAL CONCERN IN SITE GROUNDWATER (ug/l)

CHEMICALS	Range of Detected Concentrations		Federal MCL (1)	New York State MCL (1)
	Minimum	Maximum		
VOCs:				
1,1-Dichloroethene	0.20 J	26.5	7	5
Tetrachloroethene	1.30	110	5	5
Trichloroethene	0.50 J	9.85	5	5
Vinyl Chloride	0.60 J	17.0	2	2
INORGANICS				
Arsenic	1.50 B	9.70 B	50	50
Selenium	5.40	8.40 BJ	50	10

(1) Region II Drinking and Groundwater Standards Update (USEPA, 1993).

6.0 UNCERTAINTIES IN RISK ASSESSMENT

As in any risk assessment, the estimates of potential health threats (carcinogenic risks and noncarcinogenic health effects) for the Syosset Landfill site data have numerous associated uncertainties. In general, the primary areas of uncertainty include the following:

- Environmental data
- Exposure pathway assumptions
- Toxicological data
- Risk characterization

6.1 Environmental Data

Uncertainty is always involved in the estimation of chemical concentrations. Errors in the analytical data may stem from errors inherent in sampling and/or laboratory procedures. One of the most effective methods of minimizing procedural or systematic error is to subject the data to a strict quality control review. This quality control review procedure helps to eliminate many laboratory errors. However, even with all data vigorously validated, it must be realized that error is inherent in all laboratory procedures.

During CDM Federal's review of the data set, three inorganic chemicals (antimony, cadmium, and nickel) detected in well samples were also found to be detected in field blank samples. These three chemicals are considered potential chemicals of concern, but since the field blank concentrations were similar to the chemical concentrations in well sample data, the USEPA Region II Risk Assessment Specialist and Remedial Project Manager directed CDM Federal to qualitatively evaluate these chemicals in this risk assessment. A brief discussion of the detected concentrations of the chemicals and their corresponding MCL values are provided below. Toxicological profiles for these chemicals are provided in Appendix B.

In the site groundwater data set, the SQL reported for antimony is 21 ug/l; the MCL for antimony is 6 ug/l. Detected concentrations of antimony reported in field blank samples were 21.1B ug/l and 26.6 B ug/l. Concentrations of antimony in the well samples ranged from less than 21.0 ug/l (non-detect) to 25.0 B ug/l. Because the SQL is greater than the MCL, any reported concentration of antimony exceeds the MCL value and may then pose a potential risk to human health.

The SQL reported for cadmium is 2 ug/l; the MCL for cadmium is 5 ug/l. Concentrations of cadmium reported in field blank samples ranged from less than 2.0 ug/l (non-detect) to 2.8 BJ ug/l. Concentrations of cadmium reported in the well samples ranged from 2.0 ug/l to 2.9 BJ ug/l and are below the MCL.

The SQL reported for nickel is 11 ug/l; the MCL for nickel is 100 ug/l. Concentrations of nickel reported in field blank samples ranged from less than 11 ug/l (non-detect) to 13.5 B ug/l. Concentrations of nickel reported in the well samples ranged from 10.1 B ug/l to 34.2 B ug/l and are below the MCL.

The presence of field blank contamination and the subsequent treatment of data for antimony, cadmium, and nickel in a qualitative manner may underestimate the risks/hazards at the site for exposure to groundwater. The potential for this underestimation is due to the deletion of these chemicals from the data set in the quantitative risk assessment. The direct comparison of well sample results to MCLs may overestimate the risk from these chemicals since similar concentrations were detected in field blanks.

Another source of uncertainty is the site-related nature of contaminants. In this risk assessment, organic chemicals present in monitoring wells were considered to be site related. An industrial survey report (Geraghty & Miller, 1995) performed in the area adjacent to the site suggests that volatile organic chemicals present in monitoring well RW-12I may be the result of historical spills and waste practices of industries near the site. The NYSDEC will be conducting a further investigation of the sources near this well to determine if they are contributing.

6.2 Exposure Pathway Assumptions

The lack of site-specific exposure measurements requires that estimates be made on the basis of literature values and/or professional judgement. These types of estimates were required in the evaluation of exposure scenario input parameters. For example, assumptions were made for the exposure time, frequency, and duration of potential chemical exposures, as well as for the quantity of ingested and/or inhaled chemical contaminants. In general, assumptions were made based on reasonable maximum exposures.

Other standard assumptions used throughout this risk assessment (i.e., 70 kg average adult body weight) or upper-bounds of potential exposure (i.e., inhalation rate) have been used as appropriate.

Other sources of error in the risk assessment can stem from the use of estimated concentrations and can arise during the calculation of 95 percent UCLs. For example, one-half the SQL was used in the 95 percent UCL calculation as a proxy concentration for non-detect chemicals, in accordance with USEPA guidance (USEPA, 1989b).

6.3 Toxicological Data

Toxicological data uncertainty is one of the largest sources of error in this risk assessment. Numerous uncertainties are associated with USEPA-derived toxicity values used in risk assessment. One source of uncertainty may include using dose-response information from effects observed at high doses in animals to predict adverse health effects from low level exposures to humans in contact with the chemical in the environment. Another source may be the use of dose-response information from short-term exposure studies to predict the effects of long-term exposure and vice versa. Uncertainties may also arise from using dose-response information in animals to predict human health effects and from homogeneous animal and healthy human populations to predict effects likely to be observed in the general population which consists of individuals with

varying sensitivities. In addition, the inability to quantitatively evaluate all chemicals detected at the site due to the lack of sufficient toxicological data may result in underestimation of risks and/or health effects. The potential toxicological effects of these chemicals have been discussed in Section 4.3 and in Appendix B Toxicological Profiles.

6.4 Risk Characterization

Risk characterization combines the exposure point concentration with the exposure assumptions and the toxicity information. The uncertainty associated with each of these components of the risk assessment are combined in the risk characterization.

As a result of the uncertainties described above, this risk assessment should not be construed as presenting absolute risks or hazards. Rather, it is a conservative analysis intended to indicate the potential for adverse impacts to occur, based on a reasonable maximum exposure.

6.5 Central Tendency Calculations for Groundwater

Central tendency is a statistical measure that identifies the single most representative value for an entire distribution of values. As a quantitative measure of uncertainty in this risk assessment, central tendency calculations have been performed utilizing 50th percentile input parameters (i.e., exposure duration) in the risk and hazard index calculations as opposed to the more conservative parameters generally used in risk assessment calculations. Ninetieth percentile input parameters are used in the risk assessment for calculation of risk and hazard index values in a given pathway so that the combination of all intake variables results in an estimate of the RME for that pathway. The RME is the maximum exposure that is reasonably expected to occur at a site. The 50th percentile values used in the central tendency calculations are considered to be representative of the general receptor population, but may underestimate the true carcinogenic risk and/or noncarcinogenic health effects to sensitive receptors.

Table 6-1 presents the 50th percentile exposure parameters utilized in the calculation of central tendency for the exposure pathways which when combined have risk results within the upper-bounds of the 10^{-4} to 10^{-6} risk range for carcinogens. (No exposure pathways showed a hazard index in exceedance of the target level of 1 for noncarcinogens). These parameters were obtained from several USEPA guidance documents including RAGS (USEPA, 1989b) and the Exposure Factors Handbook (USEPA, 1989c), as well as through discussion with the USEPA Region II Risk Assessment Specialist. The 95 percent UCL concentrations have been utilized in these calculations.

Central tendency risk was calculated for residential adult exposure to carcinogens in site groundwater via the ingestion route since this pathway fell within the upper-bounds of the cancer risk range of 10^{-4} to 10^{-6}. Central tendency risk was also calculated for residential child exposure via ingestion and inhalation and for residential adult exposure via inhalation since the 30-year combined adult and child risks fell within the upper-bounds of the cancer risk range of 10^{-4} to 10^{-6}.

Table D-1, central tendency calculations for adult and child exposures to groundwater via ingestion, shows total carcinogenic risks of 3.8E-05 and 6.0E-05, respectively. The adult total risk of 3.8E-05 is 3.95 times less than the RME adult total risk of 1.5E-04 (Table C-1, Appendix C) and does not exceed the upper-bounds of the USEPA's 10^{-4} to 10^{-6} target risk range.

Table D-1, central tendency calculations for the 30-year combined risk for adult and child exposure to groundwater via ingestion shows a total carcinogenic risk of 9.8E-05. The 30-year combined risk of 9.8E-05 is 2.35 times less than the RME 30-year combined risk of 2.3E-04 (Table C-1, Appendix C) and does not exceed the upper-bounds of the USEPA's 10^{-4} to 10^{-6} target risk range.

Table D-2, central tendency calculations for the adult, child, and 30-year combined risk for adult and child exposure to groundwater via inhalation shows total carcinogenic risks of 7.6E-06, 2.4E-05, and 3.1E-05, respectively. The individual RME carcinogenic risks for the adult and child fell

8/4/95
CTEXPVAR1.XLS

TABLE 6-1

SYOSSET LANDFILL SITE OU 2
VARIABLES USED FOR CHRONIC DAILY INTAKE CALCULATIONS FOR CENTRAL TENDENCY EVALUATION

		CONCENTRATIONS		CONTACT PARAMETERS	TIME VARIABLES				
Matrices and Receptor Populations	Exposure Route	CW (mg/l)	CA (mg/m3)	IR (1) (variable)	ET (hr/day)	EF (days/yr)	ED (yrs)	AT (2) (years)	BW (kg)
Groundwater									
Site/Area Residents									
Adults	Ingestion	Site Data	-	1.4 l/day	-	350	9	70(9)	70
Children (0-6 years old)	Ingestion	Site Data	-	0.7 l/day	-	350	6	70(6)	15
Adults	Inhalation (Shower)	-	(3)	0.6 m3/hr	0.3	275	9	70(9)	70
Children (0-6 years old)	Inhalation (Shower)	-	(3)	0.6 m3/hr	0.3	275	6	70(6)	15

NOTES:
(1) Ingestion or inhalation rate.
(2) 70 years for carcinogens, 9 years for noncarcinogens for adult residents and 6 years for noncarcinogens for children (multiplied by 365 days).
(3) This value will be modeled using Schaum et al. (1994) based on the Andelman (1990) Shower Model.

Other Abbreviations:

CW = Chemical concentration in water
CA = Chemical concentration in air
ET = Exposure Time
EF = Exposure Frequency
ED = Exposure Duration
BW = Body Weight
AT = Averaging Time

below the upper-bounds of the USEPA's 10^{-4} to 10^{-6} target risk range. The 30-year combined central tendency risk of 3.1E-05 is 4.84 times less than the RME 30-year combined risk of 1.5E-04 (Table C-2, Appendix C) and does not exceed the upper-bounds of the USEPA's 10^{-4} to 10^{-6} target risk range.

7.0 SUMMARY OF THE BASELINE RISK ASSESSMENT

In this baseline human health risk assessment, site groundwater was quantitatively evaluated for potential health threats to human receptors via the ingestion and inhalation routes of exposure. Based on information provided to the USEPA Region II Risk Assessment Specialist, contaminated groundwater is not currently being used as a source of drinking water. The Nassau County Department of Health's Article IV concerns groundwater use in the area and states that "the Nassau Board of Health requires, insofar as possible, that all drinking water used by the public be provided by a public water system on the basis that such systems provide greater public health protection than that provided by a private water system (Nassau County Department of Health, 1988). Therefore, the current use scenario was not evaluated. Receptors including residents (adults and children) were evaluated under potential future site conditions. The results of the risk and hazard index calculations and the greatest chemical contributors to these estimates have been presented and discussed.

Chemicals of potential concern were selected for groundwater based on modified criteria outlined in RAGS (USEPA, 1989b) and presented in Section 2.3. The chemicals which were evaluated and selected as chemicals of potential concern included VOCs and inorganics. Iron and lead could not be quantitatively evaluated in this risk assessment due to their lack of established toxicity values. Two essential nutrients, potassium and sodium, were not quantitatively evaluated as their potential toxicity is significantly lower than other inorganics at the site, and most existing toxicological data pertain to dietary intake. Three inorganics, antimony, cadmium, and nickel, considered potential chemicals of concern, were not quantitatively evaluated in the risk assessment since these contaminants were detected at similar concentrations in the associated field blanks. Therefore, these chemicals were qualitatively evaluated in the risk assessment.

A Draft Risk Assessment, dated August 4, 1995, was developed using the data obtained from the OU2 RI report. Around the same time, USEPA suggested that a third round of sampling be conducted to confirm the results reported during the earlier two rounds. A third round of

groundwater sampling was conducted on July 27, 1995. Samples were analyzed for low-level volatile organic compounds. The results of the sampling effort (see Appendix F) indicated that similar contaminants detected in the earlier two rounds were still present at similar concentrations. These concentrations would have negligible impact on risk estimates. Therefore, the third round of sampling data is not included in the risk assessment.

Exposure routes and receptor groups were identified and quantitative estimates of the magnitude, frequency, and duration of exposure were made. Exposure points were estimated using the 95 percent UCL calculation, as appropriate. Chronic daily intakes for ingestion and inhalation routes were calculated for the reasonable maximum exposure (i.e., using 95 percent UCL concentrations and 90^{th} and 95^{th} percentile exposure parameters).

In the toxicity assessment, current toxicological human health data (i.e., reference doses, reference concentrations, and slope factors) were obtained from various sources and were utilized in the order specified by RAGS (USEPA, 1989b). Brief toxicological profiles for chemicals which could not be quantitatively evaluated in the risk assessment have been included in this section (4.0). Toxicological profiles for the chemicals of potential concern have been developed and are presented in Appendix B.

Risk characterization involved integrating the exposure and toxicity assessments into quantitative expressions of risks/health effects. Specifically, chronic daily intakes were compared with concentrations known or suspected to present health risks or hazards. The carcinogenic risks and noncarcinogenic hazard index values calculated at the site are based on the reasonable maximum exposure (the highest exposure reasonably expected to occur at a site). The intent is to estimate a conservative exposure case that is still within the range of possible exposures.

In accordance with the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) Section 300.430(e)(2) for known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an incremental upper-bound lifetime cancer risk to

an individual between 10^{-4} and 10^{-6}. Per the RAGS Part B: Development of Risk-Based Preliminary Remediation Goals (USEPA, 1991b), for noncarcinogenic effects, the NCP does not specify a range, but it is generally appropriate to assume a hazard index equal to 1.

In general, the USEPA recommends a target risk range of 10^{-4} to 10^{-6} for carcinogens or hazard index of 1 for noncarcinogens) as threshold values for potential human health impacts (USEPA, 1989b). These threshold values aid in determining the objectives of the baseline human health risk assessment which include determining whether additional response action is necessary at the site, by providing a basis for determining residual chemical levels that are adequately protective of human health, by providing a basis for comparing potential health impacts of various remedial alternatives, and to help support selection of the "no action" remedial alternative, where appropriate. In addition, the chemicals of potential concern in site groundwater were compared to federal and state MCLs (Table 5-3). All VOC maximum detections exceed their respective established MCLs. The maximum concentrations of the two inorganic analytes (arsenic and selenium) do not exceed their respective MCLs.

Human Health Risks and Hazards Identified

The following discussion presents by receptor group carcinogenic risks and noncarcinogenic hazard index values in exceedance of the USEPA's target levels for groundwater.

Potential future residents (adults and children) at the site were quantitatively evaluated for site groundwater exposure via ingestion and inhalation of VOCs (during and after showering). The carcinogenic risk for adults via ingestion was within the upper-bound of the USEPA's target risk range of 10^{-4} to 10^{-6}. The chemicals 1,1-dichloroethene, tetrachloroethene, vinyl chloride, and arsenic were the main contributors to the overall risk. The carcinogenic risks for children via ingestion, as well as both adult and child exposure to groundwater via inhalation, do not exceed the target risk range.

The ingestion of groundwater by adults and children showed hazard index values that do not exceed the USEPA's target index of 1. The hazard index values for exposure to groundwater by adults and children via inhalation were not calculated due to the lack of established inhalation reference doses for the chemicals of potential concern. Based on the media evaluated (groundwater) and toxicological analysis, it is expected that risks from this route of exposure would be significantly less than the risks from ingestion.

Site-specific uncertainties relating to the risk assessment were qualitatively and quantitatively addressed in Section 6.0.

In accordance with standard risk assessment practice, central tendency calculations were performed as a quantitative measure of uncertainty in the risk assessment and are presented in Tables D-1 and D-2 in Appendix D. The 50^{th} percentile parameters used in these calculations and presented in Table 6-1 were assumed to be representative of the general population. These central tendency calculations, however, have the potential to underestimate true risks/hazard indices for sensitive receptors.

Risk-based PRGs were not developed for residential groundwater use since no chemicals exceeded the USEPA's 10^{-4} to 10^{-6} target risk range for carcinogens or hazard index of 1 for noncarcinogens. In addition, all chemicals of potential concern have established MCLs.

REFERENCES

Amdur, M., Doull, J., and Klaassen, C. eds., 1991. In: Casarett and Doull's Toxicology: The Basic Science of Poisons, 4th ed. Pergamon Press, New York.

Andelman, J., 1990. Total Exposure to Volatile Organic Compounds in Potable Water, Chapter 20. In: Significance and Treatment of Volatile Organic Compounds in Water Supplies. Editors, Cantor, K., Christman. N. Lewis, Publishers, Michigan. Pages 485-504.

Clement Associates, Inc., 1985. Chemical, Physical, and Biological Properties of Compounds Present at Hazardous Waste Sites. Final Report. Prepared for the U.S. Environmental Protection Agency. September 27, 1985.

Conway, R. ed., 1982. Environmental Risk Analysis for Chemicals. New York: Van Nostrand Reinhold Company.

Friberg., 1986. Handbook of Toxicity of Metals. 2nd edition. Volumes I and II 1986 V2 86. In Hazardous Substance Data Bank. On-line April 14, 1993.

Geraghty & Miller, Inc. 1989. Draft Interim Remedial Investigation Report for OU1. Syosset Landfill Site, Syosset, New York. Prepared for the Town of Oyster Bay, Syosset, New York. August 1989.

Geraghty & Miller, Inc., 1994. Operable Unit Two Remedial Investigation Report. Syosset Landfill Site, Syosset, New York. Prepared for the Town of Oyster Bay, Syosset, New York 1994.

Geraghty & Miller, Inc., 1995. Memorandum entitled: Industrial Area Survey Adjacent to the Syosset Landfill, Syosset, New York. July 13, 1995.

Gilbert, R.O., 1987. Statistical Methods for Environmental Pollution Monitoring, Van Nostrand Reinhold, New York, New York.

Integrated Risk Information System (IRIS), 1995. U.S. Environmental Protection Agency on-line data base of toxicity measures. Office of Research and Development, Environmental Criteria and Assessment Office, Cincinnati, Ohio. July 1995.

Lyman, W., Reehl, W., and Rosenblatt, D., 1982. Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds: New York: McGraw-Hill Book Company, Inc.

REFERENCES (Continued)

The Merck Index, 1989. An Encyclopedia of Chemicals, Drugs, and Biologicals. Eleventh edition. Ed. S. Budavari. Merck and Co., Inc. Rahway, NJ.

Nassau County Department of Health, 1988. Article IV Nassau County Public Health Ordinance, Private Drinking Systems, Nassau County Department of Health, April 13, 1988.

National Contingency Plan (NCP). Volume 40 Code of Federal Regulations (CFR) Part 300.

Olsen, M., 1995. Teleconference between Marian Olsen, USEPA Region II Risk Assessment Specialist, and CDM Federal. July 10 and 11, 1995 and August 2, 1995.

Schaum, J., Hoang, K., Kinerson, R., Moya, J., and Wang, R. 1994. Estimating Dermal and Inhalation Exposure to Volatile Chemicals in Domestic Water. In: Water Contamination and Health-Integration of Exposure Assessment, Toxicology, and Risk Assessment, R. Wang, Human Risk Assessment Branch, USEPA, ed. Marcel Dekker, Inc., New York, Basel, Hong Kong.

USEPA, 1983. Methods for Chemical Analysis of Water and Wastes, USEPA-600/4-79-020, United States Environmental Protection Agency, Cincinnati, OH. March 1983.

USEPA, 1984. Health Assessment Document for Chromium. U.S. Environmental Protection Agency. Environmental Criteria and Assessment Office. Research Triangle Park, North Carolina. USEPA 600/8-83-014F.

USEPA, 1985. Updated Mutagenicity and Carcinogenicity Assessment of Cadmium. Addendum to the Health Assessment Document for Cadmium (May 1981; USEPA/600/8-81/023). Office of Health and Environmental Assessment, Washington, DC. June 1985. USEPA 600/8-83/025F.

USEPA, 1986a. Guidelines for Carcinogen Risk Assessment, 51 Federal Register 33992, September 24, 1986.

USEPA, 1986b. Superfund Public Health Evaluation Manual. U.S. Environmental Protection Agency. Office of Emergency and Remedial Response. Washington, D.C. OSWER Directive 9285.4-1. USEPA 540 1-86-060. October 1986.

USEPA, 1986c. Health Assessment Document for Nickel and Nickel Compounds. Office of Health and Environmental Assessment, Research Triangle Park, North Carolina. USEPA 600/8-83/012FF.

USEPA, 1988. Superfund Exposure Assessment Manual. Office of Remedial Response, U.S. Environmental Protection Agency, Washington, DC. USEPA/540/1-88/001.

REFERENCES (Continued)

USEPA, 1989a. Method 524.2, Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry, Revision 3.0, Environmental Monitoring Systems Laboratory (EMSL), Office of Research and Development, United States Environmental Protection Agency, Cincinnati, OH.

USEPA, 1989b. Risk Assessment Guidance for Superfund: Human Health Evaluation Manual Part A. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency and Remedial Response. OSWER Directive 9285.701A.

USEPA, 1989c. Exposure Factors Handbook. Exposure Assessment Group, Office of Health and Environmental Assessment, U.S. Environmental Protection Agency, Washington, DC. USEPA/600/8-89/043.

USEPA, 1990a. Record of Decision: Syosset Landfill Site, Town of Oyster Bay, Nassau County, New York, September 27, 1990.

USEPA, 1990b. Contract Laboratory Program (CLP) Statement of Work for Inorganic Analysis Multi-Media, Multi-Concentration, Document Number ILM02.1.

USEPA, 1991a. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. OSWER Directive 9285.6-03.

USEPA, 1991b. Human Health Evaluation Manual Part B: Development of Risk-Based Preliminary Remediation Goals. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. OSWER Directive 9285.7-01B.

USEPA, 1992a. Contract Laboratory Program (CLP) Organics Data Review and Preliminary Review, Region II Standard Operating Procedure No. HW-6, Revision No. 8, United States Environmental Protection Agency. January 1992.

USEPA, 1992b. Evaluation of Metals Data for the Contract Laboratory Program (CLP), Inorganic Region II standard Operating Procedure No. HW-2, Revision No. 11, United States Environmental Protection Agency. January 1992.

USEPA, 1992c. Guidance for Data Useability in Risk Assessment - Final. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C. OSWER Directive 9285.7-09A. April 1992.

USEPA, 1992d. Dermal Exposure Assessment: Principles and Applications - Interim Report. U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC. USEPA/600/8-91/011B. January 1992.

REFERENCES (Continued)

USEPA, 1992e. Provisional RfD and Carcinogenicity Information for Trichloroethene. U.S. Environmental Protection Agency, Office Research and Development, Environmental Assessment Office, Cincinnati, OH. Received December 7, 1992.

USEPA, 1993. Region II Drinking and Groundwater Standards Update. Groundwater Management Section. U.S. Environmental Protection Agency. Tables 1 and 2 National Primary Drinking Water Regulations (Title 40 CFR - Part 141, 1992) and Table 5 National Secondary Drinking Water Regulations (Title 40 CFR - Part 143, 1992). July 20, 1993.

USEPA, 1994. Health Effects Assessment Summary Tables (HEAST) FY 1994-Annual and Supplements. U.S. Environmental Protection Agency, Office of Research and Development. OERR 9200.6-303 (94-1). March 1994.

Versar, 1990. Final Health and Endangerment Assessment, Syosset Landfill Site, Oyster Bay, Long Island, New York. Submitted to CDM Federal Programs Corporation. July 9, 1990.

APPENDIX A

95 PERCENT
UPPER CONFIDENCE LIMIT CALCULATIONS

GROUNDWATER

VOC:	1,1-DICHLOROETHENE		
Sample Location	Concentration (mg/l)	Q	Log of Concentration (mg/l)
PK-10D-R1	0.0005	U	-7.6
PK-10D-R2	0.0005	U	-7.6
PK-10I-R1-AV	0.0005	J	-7.6
PK-10I-R2-AV	0.0002	J	-8.5
PK-10S-R1	0.0008	J	-7.1
PK-10S-R2	0.0009	J	-7.0
RB-11D-R1	0.0005	U	-7.6
RB-11D-R2	0.0005	U	-7.6
RB-11I-R1-AV	0.00125		-6.7
RB-11I-R2-AV	0.00155		-6.5
RB-11S-R1	0.0005	U	-7.6
RB-11S-R2	0.0005	U	-7.6
RW-12D-R1	0.0005	U	-7.6
RW-12D-R2	0.0005	U	-7.6
RW-12I-R1-AV	0.014		-4.3
RW-12I-R2-AV	0.0265		-3.6
SY-3DD-R1	0.0005	U	-7.6
SY-3DD-R2	0.0005	U	-7.6

Frequency:	8/18		
Average:	0.003	Sample Std. Dev.	0.01
Average log:	-7.07	Sample Std. Dev.	1.22
UCL:	0.0044	(log value)	
Maximum:	0.0265		

GROUNDWATER

VOC:	TETRACHLOROETHENE		
Sample Location	Concentration (mg/l)	Q	Log of Concentration (mg/l)
PK-10D-R1	0.0005	U	-7.6
PK-10D-R2	0.0005	U	-7.6
PK-10I-R1-AV	0.0033		-5.7
PK-10I-R2-AV	0.00145		-6.5
PK-10S-R1	0.0013		-6.6
PK-10S-R2	0.0013		-6.6
RB-11D-R1	0.0005	U	-7.6
RB-11D-R2	0.0005	U	-7.6
RB-11I-R1-AV	0.019		-4.0
RB-11I-R2-AV	0.023		-3.8
RB-11S-R1	0.0005	U	-7.6
RB-11S-R2	0.0005	U	-7.6
RW-12D-R1	0.0026		-6.0
RW-12D-R2	0.0024		-6.0
RW-12I-R1-AV	0.0695		-2.7
RW-12I-R2-AV	0.11		-2.2
SY-3DD-R1	0.0005	U	-7.6
SY-3DD-R2	0.0005	U	-7.6

Frequency:	10/18		
Average:	0.01	Sample Std. Dev.	0.03
Average log:	-6.16	Sample Std. Dev.	1.81
UCL:	0.06	(log value)	
Maximum:	0.11		

GROUNDWATER

VOC:	TRICHLOROETHENE						
Sample Location	Concentration (mg/l)	Q	Log of Concentration (mg/l)	Frequency:	10/18		
				Average:	0.002	Sample Std. Dev.	0.003
				Average log:	-6.90	Sample Std. Dev.	0.98
PK-10D-R1	0.0005	U	-7.6	UCL:	0.00303	(log value)	
PK-10D-R2	0.0005	U	-7.6	Maximum:	0.00985		
PK-10I-R1-AV	0.0012		-6.7				
PK-10I-R2-AV	0.0009	J	-7.0				
PK-10S-R1	0.0005	J	-7.6				
PK-10S-R2	0.0007	J	-7.3				
RB-11D-R1	0.0005	U	-7.6				
RB-11D-R2	0.0005	U	-7.6				
RB-11I-R1-AV	0.003		-5.8				
RB-11I-R2-AV	0.00395		-5.5				
RB-11S-R1	0.0005	U	-7.6				
RB-11S-R2	0.0005	U	-7.6				
RW-12D-R1	0.0009	J	-7.0				
RW-12D-R2	0.0011		-6.8				
RW-12I-R1-AV	0.00625		-5.1				
RW-12I-R2-AV	0.00985		-4.6				
SY-3DD-R1	0.0005	U	-7.6				
SY-3DD-R2	0.0005	U	-7.6				

GROUNDWATER

VOC:	**VINYL CHLORIDE**						
Sample Location	Concentration (mg/l)	Q	Log of Concentration (mg/l)	Frequency:	5/18		
				Average:	0.002	Sample Std. Dev.	0.004
				Average log:	-7.16	Sample Std. Dev.	1.03
PK-10D-R1	0.0005	U	-7.6	UCL:	0.003	(log value)	
PK-10D-R2	0.0005	U	-7.6	Maximum:	0.017		
PK-10I-R1-AV	0.00075	J	-7.2				
PK-10I-R2-AV	0.00065	J	-7.3				
PK-10S-R1	0.0005	U	-7.6				
PK-10S-R2	0.0005	U	-7.6				
RB-11D-R1	0.0005	U	-7.6				
RB-11D-R2	0.0005	U	-7.6				
RB-11I-R1-AV	0.0005	U	-7.6				
RB-11I-R2-AV	0.0005	U	-7.6				
RB-11S-R1	0.0005	U	-7.6				
RB-11S-R2	0.0005	U	-7.6				
RW-12D-R1	0.0092		-4.7				
RW-12D-R2	0.017		-4.1				
RW-12I-R1-AV	0.001	U	-6.9				
RW-12I-R2-AV	0.0006	J	-7.4				
SY-3DD-R1	0.0005	U	-7.6				
SY-3DD-R2	0.0005	U	-7.6				

GROUNDWATER

INORGANIC:	ARSENIC		
Sample Location	Concentration (mg/l)	Q	Log of Concentration (mg/l)
PK-10D-R1	0.0097	B	-4.6
PK-10D-R2	0.0063	B	-5.1
PK-10I-R1-AV	0.0005	U	-7.6
PK-10I-R2-AV	0.0005	UJ	-7.6
PK-10S-R1	0.0019	B	-6.3
PK-10S-R2	0.0035	BJ	-5.7
RB-11D-R1	0.0005	UJ	-7.6
RB-11D-R2	0.0005	UJ	-7.6
RB-11I-R1-AV	0.0005	UJ	-7.6
RB-11I-R2-AV	0.0005	UJ	-7.6
RB-11S-R1	0.0005	UJ	-7.6
RB-11S-R2	0.0005	UJ	-7.6
RW-12D-R1	0.0005	U	-7.6
RW-12D-R2	0.0005	U	-7.6
RW-12I-R1-AV	0.0005	U	-7.6
RW-12I-R2-AV	0.0015	B	-6.5
SY-3DD-R1	0.0005	UJ	-7.6
SY-3DD-R2	0.0005	UJ	-7.6

Frequency:	5/18		
Average:	0.002	Sample Std. Dev.	0.003
Average log:	-7.05	Sample Std. Dev.	0.99
UCL:	0.0027	(log value)	
Maximum:	0.0097		

GROUNDWATER

INORGANIC:	SELENIUM		
Sample Location	Concentration (mg/l)	Q	Log of Concentration (mg/l)
PK-10D-R1	0.001	UJ	-6.9
PK-10D-R2	0.001	U	-6.9
PK-10I-R1-AV	0.001	UJ	-6.9
PK-10I-R2-AV	0.001	UJ	-6.9
PK-10S-R1	0.001	UJ	-6.9
PK-10S-R2	0.001	UJ	-6.9
RB-11D-R1	0.001	UJ	-6.9
RB-11D-R2	0.001	UJ	-6.9
RB-11I-R1-AV	0.001	UJ	-6.9
RB-11I-R2-AV	0.001	UJ	-6.9
RB-11S-R1	0.001	UJ	-6.9
RB-11S-R2	0.001	UJ	-6.9
RW-12D-R1	0.0084	BJ	-4.8
RW-12D-R2	0.0054		-5.2
RW-12I-R1-AV	0.001	UJ	-6.9
RW-12I-R2-AV	0.001	U	-6.9
SY-3DD-R1	0.001	UJ	-6.9
SY-3DD-R2	0.001	UJ	-6.9

Frequency:	2/18		
Average:	0.002	Sample Std. Dev.	0.002
Average log:	-6.70	Sample Std. Dev.	0.62
UCL:	0.0021	(log value)	
Maximum:	0.0084		

APPENDIX B

TOXICOLOGICAL PROFILES

ANTIMONY

Antimony production has been associated with an increase in lung cancer in exposed workers. An inhalation study using rats yielded suggestive evidence that antimony trioxide causes lung and liver tumors, and several antimony compounds were mutagenic when tested using bacterial test systems. Female workers exposed to antimony compounds had an increased incidence of gynecological disorders and spontaneous abortions; similar effects were observed in an animal study. Antimony also causes cardiovascular changes in humans and may damage the myocardia (Clement Associates, Inc., 1985).

The EPA has not assigned antimony a weight-of-evidence classification. This chemical has not been reviewed by the EPA for evidence of carcinogenic potential (IRIS, 1995). An oral reference dose (RfD) of 4E-04 mg/kg-day (IRIS, 1995) was developed based on a rat chronic oral bioassay by Schroeder et al. (1970). In this study, rats were administered 5 ppm of antimony tartrate in drinking water. Survival rates decreased in male rats as did the blood glucose level. Cholesterol levels were altered in both sexes. A NOEL was not established as only one level of antimony was administered. The LOAEL was 0.35 mg/kg-day. An uncertainty factor of 1000 was applied in developing the oral RfD (IRIS, 1995). An inhalation reference concentration (RfC) has not been developed.

ARSENIC

Acute exposure of humans to the metal arsenic has been associated with gastrointestinal effects, hemolysis, and neuropathy. Chronic exposure of humans to this metal can produce toxic effects on both the peripheral and central nervous systems, keratosis, hyperpigmentation, precancerous dermal lesions, and cardiovascular damage (EPA, 1984). Arsenic is embryotoxic, fetotoxic, and teratogenic in several animals species (EPA, 1984). Arsenic is a known human carcinogen (Group A) (IRIS, 1995). Epidemiological studies of workers in smelters and in plants manufacturing arsenical pesticides have shown that inhalation of arsenic is strongly associated with lung cancer and perhaps with hepatic angiosarcoma (EPA, 1984). Ingestion of arsenic has been linked to a form of skin cancer and more recently to bladder, liver, and lung cancer (Tseng et al., 1968).

EPA has developed inhalation and oral cancer slope factors for arsenic of 5.0E+01 $(mg/kg\text{-}day)^{-1}$ (EPA, 1994) and 1.50E+00 $(mg/kg\text{-}day)^{-1}$ (IRIS, 1995), respectively. In developing the inhalation slope factor, a geometric mean was calculated from data sets obtained within distinct exposed populations. The final estimate is the geometric mean of those two values (IRIS, 1995). The oral slope factor was calculated using the unit risk of 5E-05 $(ug//L)^{-1}$. This was based on an epidemiological study in Taiwan by Tseng et al. (1977) which indicated an increased incidence of skin cancer in individuals exposed to arsenic in drinking water.

EPA (IRIS, 1995) developed an oral reference dose (RfD) of 3E-04 mg/kg-day based on the Tseng et al. (1968) study which showed increased incidences of hyperpigmentation and keratosis with age and on the Tseng (1977) study. An uncertainty factor of 3 was used to develop the oral RfD. An inhalation reference concentration (RfC) has not been developed.

CADMIUM

Gastrointestinal absorption of cadmium in humans ranges from 5% to 6% (EPA, 1985). Cadmium bioaccumulates in humans, particularly in the kidney and liver (EPA, 1985). Chronic oral or inhalation exposure of humans to cadmium has been associated with renal dysfunction, itai-itai disease (bone damage), hypertension, anemia, endocrine alterations, and immunosuppression. Renal toxicity occurs in humans at a renal cortex concentration of cadmium of 200 ug/g (EPA, 1985). Epidemiological studies have demonstrated a strong association between inhalation exposure to cadmium and cancers of the lungs, kidney, and prostate (EPA, 1985). In experimental animals, cadmium induces injection-site sarcomas and testicular tumors. When administered by inhalation, cadmium chloride is a potent pulmonary carcinogen in rats. Cadmium is a well-documented animal teratogen (EPA, 1985).

EPA (IRIS, 1995) has classified cadmium as a B1 chemical (Probable Human Carcinogen) by inhalation. This classification applies to chemicals for which there is limited evidence of carcinogenicity in humans from epidemiologic studies. EPA (IRIS, 1995) has derived an inhalation slope factor of 6.3E+00 $(mg/kg\text{-}day)^{-1}$ for cadmium. This corresponds to the slope factor derived from an epidemiologic study by Thun et al. (1985). An oral reference doses (RfD) of 5.0E-04 has also been derived by EPA (IRIS, 1995). An uncertainty factor of 10 was used in developing the oral RfD. A reference concentration (RfC) for inhalation has not been determined but the chemical is currently under review by EPA.

CHROMIUM

Gastrointestinal absorption of chromium (III) is low, whereas chromium (VI) is more readily absorbed following oral exposure (EPA, 1987). Chromium is an essential micronutrient and is not toxic in trace quantities (EPA, 1980). High levels of soluble chromium (VI) and chromium (III) can produce kidney and liver damage following acute oral exposures, but target organs following chronic oral exposures have not been identified (EPA, 1984). Chronic inhalation exposures may cause respiratory system damage (EPA, 1984). Epidemiological studies of worker populations have clearly established that inhaled chromium (VI) is a human carcinogen, with the respiratory passages and the lungs as the target organs (EPA, 1984). Inhalation of chromium (III) and the ingestion of chromium (VI) or (III) have not been associated with carcinogenicity in humans or experimental animals (EPA, 1984). Certain chromium salts have been shown to be teratogenic and embryotoxic in mice and hamsters following intravenous or intraperitoneal injection (EPA, 1984).

EPA has classified inhaled chromium (VI) for carcinogenicity in Group A (Human Carcinogen) (IRIS, 1995). Inhaled chromium (III) and ingested chromium (III) and (VI) have not been classified with respect to carcinogenicity. EPA (IRIS, 1995) has developed an inhalation unit risk of 1.2E-02 $(ug/m^3)^{-1}$. This value is converted in HEAST to an inhalation slope factor of 4.1E+01 $(mg/kg\text{-}day)^{-1}$ for chromium (VI) (EPA, 1994). This is based upon an increased incidence of lung cancer in workers exposed to chromium over a 5 year period, and followed for approximately 40 years (Mancuso, 1975).

EPA (IRIS, 1995) has derived an oral reference dose (RfD) for chromium (VI) based on a study by MacKenzie et al. (1958). In this study, no adverse effects were observed in rats exposed to chromium (VI) at concentrations of 2.4 mg/kg-day in drinking water for one year. Using a NOAEL of 2.4 mg/kg-day and applying an uncertainty factor of 500, an oral RfD of 5E-03 mg/kg-day was derived (IRIS, 1995). An inhalation reference concentration (RfC) has not been developed. EPA has also developed an oral RfD of 1.0E+00 for chromium (III) (IRIS, 1995).

1,1-DICHLOROETHENE

1,1-Dichloroethene (1,1-DCE) is readily absorbed following oral and inhalation exposure (EPA, 1987) Kidney tumors and leukemia were observed in one study of mice exposed by inhalation to 1,1-DCE (EPA, 1987). 1,1-DCE is mutagenic and causes adverse reproductive effects when administered to rats and rabbits by inhalation (EPA, 1987). Chronic exposure causes liver damage, and acute exposure to high doses produces nervous system damage (EPA, 1987). 1,1-DCE is structurally related to the known carcinogen vinyl chloride (IRIS, 1995).

1,1-DCE has been classified by EPA in Group C - Possible Human Carcinogen (IRIS, 1995). EPA (IRIS, 1995) has derived cancer slope factors for both oral and inhalation exposures to 1,1-DCE based on studies by NTP (1982) and Maltoni et al. (1985), respectively. The oral slope factor is 6E-01 $(mg/kg\text{-}day)^{-1}$ and the inhalation slope factor is 1.2E+00 $(mg/kg/day)^{-1}$.

An oral reference dose (RfD) of 9E-03 mg/kg-day has been determined by EPA (IRIS, 1995). The RfD is based on a study by Quast et al. (1983) in which rats exposed to 1,1-DCE in drinking water at a dose of 9 mg/kg-day developed hepatic lesions. An uncertainty factor of 1000 was applied to the LOAEL of 9 mg/kg-day to derive the oral RfD (IRIS, 1995).

LEAD

Absorption of lead from the gastrointestinal tract of humans is estimated at 10 to 15%. For adult humans, the deposition of particulate airborne lead is 30 to 50%, and essentially all of the lead deposited is adsorbed. Lead is stored in the body in bone, kidney, and liver (EPA, 1984). The major adverse effects in humans caused by lead include alterations in the hematopoietic and nervous systems. The toxic effects are generally related to the concentration of the metal in blood. Blood concentration levels of over 80 ug/L in children and over 100 ug/L in sensitive adults can cause severe, irreversible brain damage, encephalopathy and possible death. Lower blood concentrations of lead (30-40 ug/L) have been associated in humans with altered nerve conduction, altered testicular function, renal dysfunction, and anemia. Lead exposure also has been associated in humans with spontaneous abortions, premature delivery, and early membrane rupture; however, reliable exposure estimates are lacking in these cases. Decreased fertility, phytotoxic effects and skeletal malformations have been observed in experimental animals exposed to lead (EPA, 1984).

EPA has classified lead as a Group B2 carcinogen (Probable Human Carcinogen) (IRIS, 1995). This category applies to those agents for which there is sufficient evidence of carcinogenicity in animals and inadequate evidence of carcinogenicity in humans. At present, the pharmacokinetics for lead do not allow an accurate estimate of the potential risks from exposure to lead, therefore, EPA recommends that a numerical estimate not be used. Oral ingestion of certain lead salts (lead acetate, lead phosphate, lead subacetate) has been associated in experimental animals with increased renal tumors, but no quantitative estimate of cancer potency has been developed for these various lead compounds. Doses of lead that induced kidney tumors were high and were beyond the lethal dose in humans (EPA, 1985).

EPA has noted that the available data provide an insufficient basis on which to regulate lead acetate, phosphate and subacetate as human carcinogens. EPA (IRIS, 1995) determined that health effects are apparent from exposure to lead at levels so low as to be essentially without a threshold. EPA's Reference Dose (RfD) work groups discussed this issue and considered it inappropriate to develop an oral RfD for inorganic lead. No data are available to develop an inhalation reference concentration (RfC).

NICKEL

Nickel compounds can be absorbed following inhalation, ingestion, or dermal exposure. The amount absorbed depends on the dose administered and the chemical and physical form or the particular nickel compound (EPA, 1986). Adverse effects associated with acute exposure in animals have included depressed weight gain, altered hematological parameters, and increased iron deposition in blood, heart, liver, and testes (EPA, 1987). Chronic or subchronic exposure of experimental animals to nickel has been associated with reduced weight gain, degenerative lesions of the male reproductive tract, asthma, nasal septal perforations, rhinitis, sinusitis, hyperglycemia, decreased prolactin levels, decreased iodine uptake, and vasoconstriction of the coronary vessels. Dermal exposure of humans to nickel produces allergic contact dermatitis (EPA, 1986). Teratogenic and phototoxic effects have been observed in the offspring of exposed animals (EPA, 1986). Certain nickel compounds are genotoxic in bacterial and mammalian assay systems (EPA, 1986).

Inhalation exposure of experimental animals to nickel carbonyl or nickel subsulfide induces pulmonary tumors (EPA, 1986). Several nickel salts caused localized tumors when administered by subcutaneous injection or implantation. Epidemiological evidence indicates that inhalation of nickel refinery dust and nickel subsulfide is associated with cancers of the nasal cavity, lung, larynx, kidney, and prostate (EPA, 1986). There is no evidence that nickel is carcinogenic in animals or humans when the metal is ingested, and EPA (1987) does not consider nickel to be carcinogenic by the oral route.

EPA (IRIS, 1995) has derived an oral reference dose (RfD) for nickel (soluble salts) based on a study by Ambrose et al. (1976). In this study, rats were administered nickel in the diet for 2 years at concentrations of 0, 100, 1000, or 2500 ppm. Decreased organ and body weights were observed at nickel concentrations greater than 1000 ppm diet (50 mg/kg/day). Using a NOAEL of 100 ppm diet (5 mg/kg/day) and applying an uncertainty factor of 300, an oral reference dose (RfD) of 2E-02 mg/kg/day was derived (IRIS, 1995). An inhalation reference concentration (RfC) for nickel is under review by an EPA work group.

SELENIUM

Results of studies with humans and experimental animals indicate that certain selenium compounds are readily absorbed from the gastrointestinal tract following oral exposure (EPA, 1984). The pulmonary absorption of selenium following inhalation exposure has not been well studied, although there are reports suggesting that selenium is absorbed by this route to some extent (EPA, 1984). Selenium is an essential element and therefore is nontoxic at doses necessary for normal health and nutrition. The NAS (1980) reported that an adequate and safe selenium intake for an adult human ranges from 0.05 mg/day to 0.2 mg/day. However, overexposure to selenium has been associated with adverse health effects. Adverse health effects observed in experimental animals following subchronic or chronic oral exposure to various selenium compounds have included anemia, reduced growth, increased mortality, and lesions of the liver, heart, kidney, and spleen (EPA, 1984). In humans, chronic oral exposure to selenium has been associated with alopecia, dermatitis, discoloration of the skin, loss of fingernails, muscular dysfunction, convulsions, paralysis, and increased incidences of dental carries (EPA, 1984). Headaches and respiratory irritation have been noted in humans following inhalation exposure (EPA, 1984). Studies with a variety of animals have suggested that selenium may be teratogenic; however, these studies are limited in that exposure doses are not well characterized (EPA, 1984). The potential mutagenic and teratogenic effects of selenium have not been adequately investigated (EPA, 1984).

With respect to the weight-of-evidence classification for selenium as a potential carcinogen, EPA (IRIS, 1995) has categorized selenium as a Group D chemical (Not Classified). This classification applies to those chemicals for which there is inadequate evidence of carcinogenicity in animals. An oral reference dose of 5.0E-03 mg/kg/day has been derived by EPA (IRIS, 1995). An uncertainty factor of 3 was used to develop this value.

TETRACHLOROETHENE (PCE)

The offspring of female rats and mice exposed to tetrachloroethene at 2000 mg/m^3 for seven hours daily on days 6-15 of gestation showed toxic effects, including a decrease in fetal body weight in mice and a small but significant increase in fetal resorptions in rats (EPA, 1985a,b).

Mice also exhibited teratogenic effects, including subcutaneous edema and delayed ossification of skull bones and sternebrae (EPA, 1985a,b).

The principal toxic effects of tetrachloroethene in humans and laboratory animals from both acute and longer-term exposures include central nervous system depression and fatty infiltration of the liver and kidney with concomitant changes in serum enzyme activity levels indicative of tissue damage (EPA, 1985a,b).

Individuals exposed to concentrations of tetrachloroethene ranging from 6258 to 10600 mg/m^3 experienced lassitude, mental fogginess, and exhilaration, progressing at the higher dose to signs of inebriation (EPA, 1980). Signs of central nervous system depression and cholinergic stimulation were also observed at concentrations of 1622 mg/kg tetrachloroethene in an animal study in rabbits, monkeys, rats, and guinea pigs (EPA, 1980).

Rats exposed to 1600 mg/kg tetrachloroethene seven hours per day, five days per week, 18 times over 25 days exhibited central nervous system depression and hepatic and renal hypertrophy. Rats exposed to 230 mg/kg and 470 mg/kg tetrachloroethene, eight hours a day, five days a week over a period of seven months, exhibited congestion and swelling of kidneys and liver, respectively (Carpenter, 1937). Female Sprague-Dawley rats exposed to tetrachloroethene in air five days a week for 12 months at concentrations of 300 to 600 mg/kg showed liver atrophy, and high-dose females developed an increased incidence of fluid-filled cysts in the liver (EPA, 1980).

Fatty infiltration in livers and other liver function alterations were noted in mice, guinea pigs, and rabbits (EPA, 1985a,b; NCI, 1977).

Three of seven men occupationally exposed to tetrachloroethene at concentrations of 1890 to 2600 mg/m^3 showed evidence of impaired liver function (EPA, 1980).

Tetrachloroethene was formerly classified as a Group B2 carcinogen (EPA, 1985a). This classification is currently under reconsideration (IRIS, 1995). The decision whether tetrachloroethene will be classified as a Group B2 or Group C carcinogen is pending. Cancer slope factors for exposure to tetrachloroethene by ingestion and inhalation are currently under review but have been provided by the National Center for Environmental Assessment as 5.2E-02 $(mg/kg\text{-}day)^{-1}$ and 2.0E-03 $(mg/kg\text{-}day)^{-1}$, respectively (EPA, 1995).

TETRACHLOROETHENE (PCE) (Cont'd)

The oral RfD of 1E-02 mg/kg/day (IRIS, 1995) is based on a study conducted by Buben and O'Flaherty (1985), in which Swiss-Cox mice were exposed to tetrachloroethene in corn oil by gavage at doses of 0, 20, 100, 200, 500, 1500, and 2000 mg/kg for 5 days/week for 6 weeks. Several parameters were monitored to evaluate liver toxicity, including liver weight/body weight ratio, hepatic triglyceride concentration, DNA content, histopathological evaluation and serum enzyme levels. At doses of 100 mg/kg, liver triglyceride levels and liver weight/body weight ratios were significantly higher than in control animals. The no observed adverse effect level (NOAEL) of 20 mg/kg-day was adjusted for the treatment schedule of 5 days/weeks to arrive at a NOAEL of 14 mg/kg-day. An uncertainty factor of 1000 was applied to the NOAEL to account for intraspecies variability, interspecies variability, and extrapolation of a subchronic effect level to its chronic variability (IRIS, 1995).

TRICHLOROETHENE (TCE)

Trichloroethene (TCE) is a colorless liquid mainly used as a metal degreaser. It is volatile with a sweet order similar to chloroform. Trichloroethene was once used as a general anesthetic, but its use has been discontinued.

Trichloroethene is a central nervous system depressant following acute and chronic exposure. High level exposure can result in death due to the respiratory and cardiac failure.

Industrial use of trichloroethylene is often associated with dermatological problems including reddening and burning skin on contact and dermatitis resulting from vapors. These effects are usually the result of contact with concentrated solvent, however, and no effects have been reported from exposure to tricholoroethene in dilute, aqueous solutions (EPA, 1985a).

The heptoatoxic potential of tricholoroethene has been evaluated to human and laboratory animal studies. Animal studies have revealed a transient increase in liver weights, but relative liver weights decreased postexposure (Kjhellstrand et al., 1983). Observations of liver or renal dysfunction in workers have been infrequent, and factors other than tricholoroethene complicate interpretation of hepatorenal disturbances (EPA, 1985a).

Several epidemiological studies reported no significant excess cancer risk associated with occupational exposure to tricholoroethene (Axelson et al., 1978, Tola et al., 1980, Malek at al., 1979). In a follow-up to one of these studies, Axelson (1986a, 1986b) observed a slight excess of bladder cancer and lymphoma. In other epidemiological studies, no associations were found between trichlorethylene exposure and liver cancer (Novotna et al. 1979, Paddle 1983) or malignant lymphoma (Hardell et al., 1981). Due to limitations with these studies, the available human studies do not allow a definite conclusion regarding the carcinogenicity of tricholoroethene in humans.

Studies investigating the carcinogenic potential of tricholoroethene have been conducted, and two of these studies revealed significant increases in the incidence of liver tumors among both sexes of B6C3F, mice exposed by gavage (NCI, 1976; NTP, 1982).

Tricholorethene was formerly classified as a group B2 carcinogen (EPA, 1985b). This classification is currently being reconsidered by EPA (IRIS, 1995). The carcinogenic slope factors for ingestion and inhalation of 1.1E-02 $(mg/kg\text{-}day)^{-1}$ and 6.0E-03 $(mg/kg\text{-}day)^{-1}$ respectively, are currently being reevaluated but have been provided by the National Center for Environmental Assessment (EPA, 1995).

TRICHLOROETHENE (TCE) (Cont'd)

An oral RfD for trichloroethene is not currently available on EPA's IRIS or HEAST. A provisional RfD of 6.0E-03 mg/kg-day (EPA, 1995) has been developed based on a 6-month drinking water study of mice by Tucker et al. (1982). In this study, groups of 30 male and 30 female CD-1 mice received trichloroethene at average doses of 0, 18.4, 216.7, 393.0, and 660.2 mg/kg/day for males and 0, 17.9, 193.0, 437.1, and 793.3 mg/kg/day for females. Increased relative liver and kidney weights, decreases in terminal body weights, and elevated protein and ketone levels in urine were observed in high-dose female and male mice. The NOAEL identified from this study is 18.4 mg/kg/day. An uncertainty factor of 3000 was applied to the NOAEL to compensate for interspecies extrapolation, intraspecies variation, extrapolation to chronic duration, and for weakness of the data base.

VINYL CHLORIDE

Vinyl chloride is a human carcinogen that causes angiosarcomas of the liver and tumors of the brain, lung, and hemolymphopoietic system. There is a suggestive evidence that vinyl chloride has teratogenic and reproductive effects in both humans and animals. Chronic human exposure to vinyl chloride is associated with multiple systemic disorders, including a sclerotic syndrome, acro-osteolysis, and liver damage. Acute human exposure to high concentrations can cause narcosis, respiratory tract irritation, bronchitis, and memory disturbances. Chronic exposure by animals can result in lesions of the liver, kidneys, spleen, and lungs (Clement Associates, Inc., 1985).

Vinyl chloride is classified as a Group A chemical (Human Carcinogen) (EPA, 1994). EPA (1994) has developed an oral slope factor of 1.9E+00 $(mg/kg\text{-}day)^{-1}$ based on a dietary study in which rats fed vinyl chloride for 1001 days developed lung and liver tumors. An inhalation slope factor of 3E-01 $(mg/kg\text{-}day)^{-1}$ has also been developed based on a rat study in which liver tumors resulted (EPA, 1994).

No oral references doses (RfDs) or inhalation reference concentrations (RfCs) have been developed for vinyl chloride.

REFERENCES

Antimony

Clement Associates, Inc. 1985. Chemical, Physical, and Biological Properties of Compounds Present at Hazardous Waste Sites. Final Report. September 27, 1985.

Integrated Risk Information System (IRIS). 1995. U.S. Environmental Protection Agency. On-line data base of toxicity measures. Office of Research and Development, Environmental Criteria and Assessment Office, Cincinnati, OH. July.

Schroeder, H., Mitchener, M., and Nasor, A. 1970. Zirconium, niobium, antimony, vanadium and lead in rats: Life-term studies. J. Nutrition. 100:59-66.

Arsenic

Environmental Protection Agency (EPA). 1984. Health Assessment Document for Inorganic Arsenic. Office of Health and Environmental Assessment, Washington, D.C. March 1984. EPA 600/8-83-021F.

Environmental Protection Agency (EPA). 1994. Health Effects Assessment Summary Tables (HEAST) FY-1994 Annual. U.S. Environmental Protection Agency. Office of Research and Development. OERR 9200.6-303 (94-1). March.

Integrated Risk Information System (IRIS). 1995. U.S. Environmental Protection Agency. On-line data base of toxicity measures. Office of Research and Development, Environmental Criteria and Assessment Office, Cincinnati, OH. July.

Tseng, W.P., Chu, H.M., How, S.W., Fong, J.M., Lin, C.S., and Yeh, S. 1968. Prevalence of Skin Cancer in an Endemic Area of Chronic Arsenicism in Taiwan. J. Natl. Cancer Inst. 40:453-463.

Tseng, W.P. 1977. Effects and Dose-Response Relationships of Skin Cancer and Blackfoot Disease with Arsenic. Environ. Health Perspect. 19:109-119.

Cadmium

Environmental Protection Agency (EPA). 1985. Updated Mutagenicity and Carcinogenicity Assessment of Cadmium. Addendum to the Health Assessment Document for Cadmium (May 1981; EPA/600/8-81/023). Office of Health and Environmental Assessment, Washington, DC. June 1985. EPA 600/8-83-025F.

Integrated Risk Information System (IRIS). 1995. U.S. Environmental Protection Agency. On-line data base of toxicity measures. Office of Research and Development, Environmental Criteria and Assessment Office, Cincinnati, OH. July.

Thun, M., Schnorr, T., Smith, A., Halperin, W., and Lemen, B. 1985. Mortality among a cohort of U.S. cadmium production workers - an update. NJCI 74:325-333.

Chromium

Environmental Protection Agency (EPA). 1980. Ambient Water Quality Criteria for Chromium. Office of Water Regulations and Standards, Washington, D.C. EPA 440/5-80-035.

Environmental Protection Agency (EPA). 1984. Health Assessment Document for Chromium. Environmental Criteria and Assessment Office. Research Triangle Park, North Carolina. EPA 600/8-83-014F.

Environmental Protection Agency (EPA). 1987. Draft Health Advisory for Chromium. Office of Drinking Water, Washington, D.C. March 31, 1987.

Environmental Protection Agency (EPA). 1994. Health Effects Assessment Summary Tables (HEAST) FY-1994 Annual. U.S. Environmental Protection Agency. Office of Research and Development. OERR 9200.6-303 (94-1). March.

Integrated Risk Information System (IRIS). 1995. U.S. Environmental Protection Agency. On-line data base of toxicity measures. Office of Research and Development, Environmental Criteria and Assessment Office, Cincinnati, OH. July.

Mackenzie, R.D., Byerrum, R.U., Decker, C.F., Hoppert, C.A., and Longham, R.F. 1958. Chronic Toxicity Studies II. Hexavalent and Trivalent Chromium Administered in Drinking Water to Rats. Am. Med. Assoc. Arch. Ind. Health. 18:232-234. As cited in IRIS, 1995.

Mancuso, T.F. 1975. International Conference on Heavy Metals in the Environment, Toronto, Canada. As cited in EPA 1984.

1,1-Dichloroethene

Environmental Protection Agency (EPA). 1987. Health Advisory for 1,1-Dichloroethylene. Office of Drinking Water, Washington, D.C. March 31, 1987.

Integrated Risk Information System (IRIS). 1995. U.S. Environmental Proection Agency. On-line data base of toxicity measures. Office of Research and Development, Environmental Criteria and Assessment Office, Cincinnati, OH. July.

Maltoni, C., LeFemine, G., Cotti, G., Chieco, P., and Patella, V. 1985. Experimental Research on Vinylidene Chloride Carcinogenesis. In: Archives of Research on Industrial Carcinogenesis, Vol. III. Maltoni, C. and Mehlman, M. ed. Princeton Scientific Publishers, Princeton, New Jersey.

National Toxicology Program (NTP). 1982. NTP Technical Report on the Carcinogenesis Bioassay of Vinylidene Chloride in F344/N in Rats and B6C3F Mice (Gavage Study). (CAS No. 75-35-4). NTP No. 80-82. NIH Publication No. 82-1784. NTP Research Triangle Park, NC and Bethesda, MD. U.S. Department of Health and Human Services, Public Health Services, National Institute of Health.

Quast, J.F., Humiston, C.G., Wade, C.E., Ballard, J., Bever, J.E., Schwetz, R.W., and Norris, J.M. 1983. A chronic toxicity and oncogenicity study in rats and subchronic toxicity study in dogs on ingested vinylidene chloride. Fund. Appl. Toxicol. 3:55-62.

Lead

Environmental Protection Agency (EPA). 1984. Health Effects Assessment for Lead. Environmental Criteria and Assessment Office, Cincinnati, Ohio. EPA/540/1-86-055.

Environmental Protection Agency (EPA), 1985. National Primary Drinking Water Regulations; Synthetic Organic Chemicals, Inorganic Chemicals and Microorganisms; Proposed Rule. 40 CFR Part 141. Fed. Reg. 50:46967-4705 (November 13, 1985).

Integrated Risk Information System (IRIS). 1995. U.S. Environmental Proection Agency. On-line data base of toxicity measures. Office of Research and Development, Environmental Criteria and Assessment Office, Cincinnati, OH. July.

Nickel

Ambrose, A.M., Larson, D.S., Borzelleca, J.R., and Hennigar, G.R. 1976. Long-term Toxicologic Assessment of Nickel in Rats and Dogs. J. Food Sci. Technol. 13:181-187.

Environmental Protection Agency (EPA). 1986. Health Assessment Document for Nickel and Nickel Compounds. Office of Health and Environmental Assessment, Research Triangle Park, North Carolina. EPA 600/8-83-012FF.

Environmental Protection Agency (EPA). 1987. Health Advisory for Nickel. Office for Drinking Water, Washington, D.C. March 31, 1987.

Integrated Risk Information System (IRIS). 1995. U.S. Environmental Protection Agency. On-line data base of toxicity measures. Office of Research and Development, Environmental Criteria and Assessment Office, Cincinnati, OH. July.

Selenium

Environmental Protection Agency (EPA). 1984. Health Effects Assessment for Selenium (and Compounds). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-86-058. September 1984.

Integrated Risk Information System (IRIS). 1995. U.S. Environmental Protection Agency. On-line data base of toxicity measures. Office of Research and Development, Environmental Criteria and Assessment Office, Cincinnati, OH. July.

National Academy of Sciences (NAS). 1980. Drinking Water and Health. Volume 3. National Academy Press, Washington, D.C.

Tetrachloroethene

Buben, J.A. and O'Flaherty, E.J. 1985. Delineation of the Role of Metabolism in the Hepatotoxicity of Trichloroethylene and Perchloroethylene: A dose-effect study. Toxicol. Appl. Pharmacol. 78:105-122.

Carpenter, C.P. 1937. The Chronic Toxicity of Tetrachloroethylene. J. Ind. Hyg. Toxicol. 19:323-326.

Environmental Protection Agency (EPA). 1980. Ambient Water Quality Criteria for Tetrachloroethylene. Office of Water Regulations and Standards. Criteria and Standards Division, Washington, D.C. October. EPA, 440/5-80-073.

Environmental Protection Agency (EPA). 1985a. Health Assessment Document for Tetrachloroethylene (Perchloroethylene). Office of Health and Environmental Assessment, Washington, D.C. July. EPA 600/8-82-005F.

Environmental Protection Agency (EPA). 1985b. Drinking Water Criteria Document for Tetrachloroethylene. Office of Drinking Water, Criteria and Standards Division, Washington, D.C. April.

Environmental Protection Agency (EPA). 1995. Obtained by the EPA Region II Risk Assessment Specialist from the National Center for Environmental Assessment, July 31, 1995.

Integrated Risk Information System (IRIS). 1995. U.S. Environmental Protection Agency. On-line data base of toxicity measures. Environmental Criteria and Assessment Office, Cincinnati, OH. July.

NCI (National Cancer Institute). 1977. Bioassay of Tetrachloroethylene for Possible Carcinogenicity. CAS No. 127-18-4. NCI Carcinogenesis Technical Report Series No. 13. Washington, D.C. DHEW (NIH) Publication No. 77-813.

Trichloroethene

Axelson, O. 1986a. Epidemiological Studies of Workers with Exposure to Tri- and Tetrachloroethylene. Toxico. Lett. 31 (Suppl): 17.

Axelson, O. 1986b. Epidemiological Studies of Workers Exposed to Tri- and Tetrachloroethylene. In: P.L. Chambers, P. Gehring, F. Saski, eds. New Concepts and Developments in Toxicology. Proceedings of the 4th International Congress of Toxicology. Amsterdam. The Netherlands: Elsevier Science Publishers.

Axelson, O., K. Andersson, C. Hogstedt, B. Homber, G. Molina, and A. DeVerdier. 1978. A Cohort Study of Trichloroethylene Exposure and Cancer Mortality. J. Occup. Med. 20:194196.

Environmental Protection Agency (EPA). 1985a. Health Assessment Document for Tricholoroethylene. Environmental Criteria and Assessment Office. Research Triangle Park,

North Carolina, EPA/600/8-22/006F.

Environmental Protection Agency (EPA). 1985b. National Primary Drinking Water Regulations; Volatile Synthetic Organic Chemicals; Final Rule. Fed. Reg. 40:46880-46901 (November 13).

Environmental Protection Agency (EPA). 1995. Obtained by the EPA Region II Risk Assessment Specialist from the National Center for Environmental Assessment, July 10 and 31, 1995.

Hardell, W., M. Erikkson, P. Lenner, and E. Lungren. 1981. Malignant Lymphoma and Exposure to Chemicals, Especially Organic Solvents, Chlorophenols and Phenoxy Acids: A Case-Control Study. Br. J. Cancer. 43: 169-176.

Integrated Risk Information System (IRIS). 1995. U.S. Environmental Protection Agency. On-line data base of toxicity measures. Office of Research and Development, Environmental Criteria and Assessment Office, Cincinnati, OH. July.

Kjhellstrand, P., Holmquist, B., Alm, P., Kanje, M., Romare, S., Jonsson, I., Mannson, L., and Bjerkemo, M. 1983. Trichloroethylene: Further Studies of the Effects on Body and Organ Weights and Plasma Butytyl Cholinesterase Activity in Mice. Acta. Pharmacol. Toxicol. 43:375-384.

Malek, B., B. Kremarova, and A. Rodova. 1979. An Epidemiological Study of Hepatic Tumor Incidence in Subjects Working with Trichloroethylene. II Negative Result of Retrospective Investigations in Dry Cleaners. Pracov. Lek. 31:124-126.

NCI (National Cancer Institute). 1976. Carcinogenesis Bioassay of Trichloroethylene. CAS No. 79-01-6. NCI-CG-TR-2.

NTP (National Toxicology Program). 1982. Carcinogenesis Bioassay of Trichloroethylene. CAS No. 79-01-6. NTP 81-84. NIH Publication No. 82-1799. Draft.

Novotna, E., A. David, and B. Malek. 1979. An Epidemiological Study of Hepatic Tumor Incidence in Subjects Working with Trichloroethylene. 1. Negative Result of Retrospective Investigations in Subjects with Primary Liver Cancer. Pracov. Lek. 31:121-123 (cited in EPA 1985b).

Paddle, G.M. 1983. Incidence of Liver Cancer and Trichloroethylene Manufacture: Joint Study by Industry and a Cancer Registry. Brit. Med. J. 286:846 (cited in EPA 1985b).

Tola, S., R. Vilhumen, E. Jarvinen, and M.L. Korkola. 1980. A Cohort Study on Workers Exposed to Trichloroethylene. J. Occup. Med. 22:737-740.

Tucker, A.N., V.M. Sanders, D.W. Barnes, et al. 1982. Toxicology of Trichloroethylene in the Mouse. Toxicol. Appl. Pharmacol. 62:351-357.

Vinyl Chloride

Clement Associates, Inc. 1985. Chemical, Physical, and Biological Properties of Compounds Present at Hazardous Waste Sites. September 27, 1985.

Environmental Protection Agency (EPA). 1994. Health Effects Assessment Summary Tables (HEAST) FY-1994 Annual. U.S. Environmental Protection Agency. Office of Research and Development. OERR 9200.6-303 (94-1). March.

APPENDIX C

SPREADSHEET CALCULATIONS

8/2/95
GW-IN-RES.XLS

TABLE C-1

GROUNDWATER INGESTION PATHWAY
SYOSSET LANDFILL SITE OU 2 - FUTURE- USE SCENARIO
RISKS TO SITE/AREA RESIDENTS

CARCINOGENS - REASONABLE MAXIMUM CASE GROUNDWATER INGESTION EXPOSURE: Adults

Chronic Daily Intake= (mg/kg-day) = Water Concentration X Ingestion Rate X Exposure Frequency X Exposure Duration X 1/Body Weight X 1/Averaging Time

mg/l X 2 l/day X 350 days/year X 24 years X 1/70 kg X 1/25550 days

Chemicals	Water Concentration	Ingestion Rate	Exposure Frequency	Exposure Duration	Body Weight	Averaging Time	Chronic Daily Intake (CDI)	Slope Factor (SF)	RISK = (CDI*SF)
1,1-Dichloroethene	4.40E-03	2	350	24	70	25550	4.1E-05	6.0E-01	2.5E-05
Tetrachloroethene	6.00E-02	2	350	24	70	25550	5.6E-04	5.2E-02	2.9E-05
Trichloroethene	3.03E-03	2	350	24	70	25550	2.8E-05	1.1E-02	3.1E-07
Vinyl Chloride	3.00E-03	2	350	24	70	25550	2.8E-05	1.9E+00	5.4E-05
Arsenic	2.70E-03	2	350	24	70	25550	2.5E-05	1.5E+00	3.8E-05
								TOTAL RISK =	1.5E-04

CARCINOGENS - REASONABLE MAXIMUM CASE GROUNDWATER INGESTION EXPOSURE: Children (0-6 years old)

Chronic Daily Intake= (mg/kg-day) = Water Concentration X Ingestion Rate X Exposure Frequency X Exposure Duration X 1/Body Weight X 1/Averaging Time

mg/l X 1 l/day X 350 days/year X 6 years X 1/15 kg X 1/25550 days

Chemicals	Water Concentration	Ingestion Rate	Exposure Frequency	Exposure Duration	Body Weight	Averaging Time	Chronic Daily Intake (CDI)	Slope Factor (SF)	RISK = (CDI*SF)
1,1-Dichloroethene	4.40E-03	1	350	6	15	25550	2.4E-05	6.0E-01	1.4E-05
Tetrachloroethene	6.00E-02	1	350	6	15	25550	3.3E-04	5.2E-02	1.7E-05
Trichloroethene	3.03E-03	1	350	6	15	25550	1.7E-05	1.1E-02	1.8E-07
Vinyl Chloride	3.00E-03	1	350	6	15	25550	1.6E-05	1.9E+00	3.1E-05
Arsenic	2.70E-03	1	350	6	15	25550	1.5E-05	1.5E+00	2.2E-05
								TOTAL RISK =	8.5E-05

30-YEAR COMBINED RISK (ADULT + CHILD) = 2.3E-04

8/2/95
GW-IN-RES.XLS

TABLE C-1

GROUNDWATER INGESTION PATHWAY
SYOSSET LANDFILL SITE OU 2 - FUTURE- USE SCENARIO
RISKS TO SITE/AREA RESIDENTS

NONCARCINOGENS - REASONABLE MAXIMUM CASE GROUNDWATER INGESTION EXPOSURE: Adults

Chronic Daily Intake= (mg/kg-day) = Water Concentration X Ingestion Rate X Exposure Frequency X Exposure Duration X 1/Body Weight X 1/Averaging Time

mg/l X 2 l/day X 350 days/year X 24 years X 1/70 kg X 1/8760 days

Chemicals	Water Concentration	Ingestion Rate	Exposure Frequency	Exposure Duration	Body Weight	Averaging Time	Chronic Daily Intake (CDI)	Reference Dose (RfD)	HQ= CDI/RfD
1,1-Dichloroethene	4.40E-03	2	350	24	70	8760	1.2E-04	9.0E-03	1.3E-02
Tetrachloroethene	6.00E-02	2	350	24	70	8760	1.6E-03	1.0E-02	1.6E-01
Trichloroethene	3.03E-03	2	350	24	70	8760	8.3E-05	6.0E-03	1.4E-02
Arsenic	2.70E-03	2	350	24	70	8760	7.4E-05	3.0E-04	2.5E-01
Selenium	2.10E-03	2	350	24	70	8760	5.8E-05	5.0E-03	1.2E-02

HAZARD INDEX = 4.5E-01

NONCARCINOGENS - REASONABLE MAXIMUM CASE GROUNDWATER INGESTION EXPOSURE: Children (0-6 years old)

Chronic Daily Intake= (mg/kg-day) = Water Concentration X Ingestion Rate X Exposure Frequency X Exposure Duration X 1/Body Weight X 1/Averaging Time

mg/l X 1 l/day X 350 days/year X 6 years X 1/15 kg X 1/2190 days

Chemicals	Water Concentration	Ingestion Rate	Exposure Frequency	Exposure Duration	Body Weight	Averaging Time	Chronic Daily Intake (CDI)	Reference Dose (RfD)	HQ= CDI/RfD
1,1-Dichloroethene	4.40E-03	1	350	6	15	2190	2.8E-04	9.0E-03	3.1E-02
Tetrachloroethene	6.00E-02	1	350	6	15	2190	3.8E-03	1.0E-02	3.8E-01
Trichloroethene	3.03E-03	1	350	6	15	2190	1.9E-04	6.0E-03	3.2E-02
Arsenic	2.70E-03	1	350	6	15	2190	1.7E-04	3.0E-04	5.8E-01
Selenium	2.10E-03	1	350	6	15	2190	1.3E-04	5.0E-03	2.7E-02

HAZARD INDEX = 1.0E+00

8/2/95
GW-INH.XLS

TABLE C-2

GROUNDWATER INHALATION PATHWAY (SHOWER MODEL)
SYOSSET LANDFILL SITE OU 2 - FUTURE-USE SCENARIO
RISKS TO SITE/AREA RESIDENTS

C(a) = Concentration of contaminant in air (mg/m3)
C(aMAX) = Maximum concentration of contaminant in air (mg/m3)
t1 = Time of shower (hr)
t2 = Time after shower (hr)

Equation:

	C(a) = (mg/m3)	[C(aMAX)/2 (mg/m3)	x	t1] (hr)	+ [C(aMAX) (mg/m3)	x	t2] (hr)	/	(t1 + t2) (hr)
Chemicals:									
1,1-Dichloroethene	3.3E-02	2.1E-02		0.2	4.1E-02		0.3		0.5
Tetrachloroethene	4.5E-01	2.8E-01		0.2	5.6E-01		0.3		0.5
Trichloroethene	2.3E-02	1.4E-02		0.2	2.8E-02		0.3		0.5
Vinyl Chloride	2.3E-02	1.4E-02		0.2	2.8E-02		0.3		0.5

C(aMAX) = Maximum air concentration in bathroom (mg/m3)
C(w) = Water concentration (mg/l)
f = Fraction volatilized (unitless)
F(w) = Water flow rate (l/hr)
V(a) = Bathroom volume (m3)

Equation:

	C(aMAX) = (mg/m3)	[C(w) (mg/l)	x	f (unitless)	x	F(w) (l/hr)	x	t1] (hr)	/	V(a) (m3)
Chemicals:										
1,1-Dichloroethene	4.1E-02	4.40E-03		0.75		750		0.2		12
Tetrachloroethene	5.6E-01	6.00E-02		0.75		750		0.2		12
Trichloroethene	2.8E-02	3.03E-03		0.75		750		0.2		12
Vinyl Chloride	2.8E-02	3.00E-03		0.75		750		0.2		12

8/2/95
GW-INH.XLS

TABLE C-2

GROUNDWATER INHALATION PATHWAY (SHOWER MODEL)
SYOSSET LANDFILL SITE OU 2 - FUTURE-USE SCENARIO
RISKS TO SITE/AREA RESIDENTS

CARCINOGENS - REASONABLE MAXIMUM CASE GROUNDWATER INHALATION EXPOSURE: Adults

Chronic Daily Intake= (mg/kg-day) = Air Concentration X Inhalation Rate X Exposure Time X Exposure Frequency X Exposure Duration X 1/Body Weight X 1/Averaging Time

mg/m3 X 0.6 m3/hr X 0.5 hr/day X 350 days/year X 24 years X 1/70 kg X 1/25550 days

Chemicals	Air Concentration	Inhalation Rate	Exposure Time	Exposure Frequency	Exposure Duration	Body Weight	Averaging Time	Chronic Daily Intake (CDI)	Slope Factor (SF)	RISK = (CDI*SF)
1,1-Dichloroethene	3.3E-02	0.6	0.5	350	24	70	25550	4.6E-05	1.2E+00	5.6E-05
Tetrachloroethene	4.5E-01	0.6	0.5	350	24	70	25550	6.3E-04	2.0E-03	1.3E-06
Trichloroethene	2.3E-02	0.6	0.5	350	24	70	25550	3.2E-05	6.0E-03	1.9E-07
Vinyl Chloride	2.3E-02	0.6	0.5	350	24	70	25550	3.2E-05	3.0E-01	9.7E-06

TOTAL RISK = 6.7E-05

CARCINOGENS - REASONABLE MAXIMUM CASE GROUNDWATER INHALATION EXPOSURE: CHILDREN (0-6 years old)

Chronic Daily Intake= (mg/kg-day) = Air Concentration X Inhalation Rate X Exposure Time X Exposure Frequency X Exposure Duration X 1/Body Weight X 1/Averaging Time

mg/m3 X 0.6 m3/hr X 0.5 hr/day X 350 days/year X 6 years X 1/15 kg X 1/25550 days

Chemicals	Air Concentration	Inhalation Rate	Exposure Time	Exposure Frequency	Exposure Duration	Body Weight	Averaging Time	Chronic Daily Intake (CDI)	Slope Factor (SF)	RISK = (CDI*SF)
1,1-Dichloroethene	3.3E-02	0.6	0.5	350	6	15	25550	5.4E-05	1.2E+00	6.5E-05
Tetrachloroethene	4.5E-01	0.6	0.5	350	6	15	25550	7.4E-04	2.0E-03	1.5E-06
Trichloroethene	2.3E-02	0.6	0.5	350	6	15	25550	3.8E-05	6.0E-03	2.3E-07
Vinyl Chloride	2.3E-02	0.6	0.5	350	6	15	25550	3.8E-05	3.0E-01	1.1E-05

TOTAL RISK = 7.8E-05

30-YEAR COMBINED RISK (ADULT + CHILD) = 1.5E-04

8/2/95
GW-INH.XLS

TABLE C-2

GROUNDWATER INHALATION PATHWAY (SHOWER MODEL)
SYOSSET LANDFILL SITE OU 2 - FUTURE-USE SCENARIO
RISKS TO SITE/AREA RESIDENTS

NONCARCINOGENS - REASONABLE MAXIMUM CASE GROUNDWATER INHALATION EXPOSURE: Adults

Chronic Daily Intake= (mg/kg-day)	Air Concentration	X Inhalation Rate	X Exposure Time	X Exposure Frequency	X Exposure Duration	X 1 / Body Weight	X 1 / Averaging Time			
	mg/m3	X 0.6 m3/hr	X 0.5 hr/day	X 350 days/year	X 24 years	X 1 / 70 kg	X 1 / 8760 days			
Chemicals	Air Concentration	Inhalation Rate	Exposure Time	Exposure Frequency	Exposure Duration	Body Weight	Averaging Time	Chronic Daily Intake (CDI)	Reference Dose (RfD)	HQ= CDI/RfD

No chemicals of potential concern have established inhalation references doses.

NONCARCINOGENS - REASONABLE MAXIMUM CASE GROUNDWATER INHALATION EXPOSURE: Children (0-6 years old)

Chronic Daily Intake= (mg/kg-day)	Air Concentration	X Inhalation Rate	X Exposure Time	X Exposure Frequency	X Exposure Duration	X 1 / Body Weight	X 1 / Averaging Time			
	mg/m3	X 0.6 m3/hr	X 0.5 hr/day	X 350 days/year	X 6 years	X 1 / 70 kg	X 1 / 2190 days			
Chemicals	Air Concentration	Inhalation Rate	Exposure Time	Exposure Frequency	Exposure Duration	Body Weight	Averaging Time	Chronic Daily Intake (CDI)	Reference Dose (RfD)	HQ= CDI/RfD

No chemicals of potential concern have established inhalation references doses.

APPENDIX D

CENTRAL TENDENCY CALCULATIONS

8/2/95
GW-IN-RESCTC.XLS

TABLE D-1

CENTRAL TENDENCY CALCULATION
GROUNDWATER INGESTION PATHWAY
SYOSSET LANDFILL SITE OU 2 - FUTURE- USE SCENARIO
RISKS TO SITE/AREA RESIDENTS

CARCINOGENS - REASONABLE MAXIMUM CASE GROUNDWATER INGESTION EXPOSURE: Adults

Chronic Daily Intake= (mg/kg-day) = Water Concentration X Ingestion Rate X Exposure Frequency X Exposure Duration X 1/Body Weight X 1/Averaging Time

mg/l X 1.4 l/day X 350 days/year X 9 years X 1/70 kg X 1/25550 days

Chemicals	Water Concentration	Ingestion Rate	Exposure Frequency	Exposure Duration	Body Weight	Averaging Time	Chronic Daily Intake (CDI)	Slope Factor (SF)	RISK = (CDI*SF)
1,1-Dichloroethene	4.40E-03	1.4	350	9	70	25550	1.1E-05	6.0E-01	6.5E-06
Tetrachloroethene	6.00E-02	1.4	350	9	70	25550	1.5E-04	5.2E-02	7.7E-06
Trichloroethene	3.03E-03	1.4	350	9	70	25550	7.5E-06	1.1E-02	8.2E-08
Vinyl Chloride	3.00E-03	1.4	350	9	70	25550	7.4E-06	1.9E+00	1.4E-05
Arsenic	2.70E-03	1.4	350	9	70	25550	6.7E-06	1.5E+00	1.0E-05
								TOTAL RISK =	3.8E-05

CARCINOGENS - REASONABLE MAXIMUM CASE GROUNDWATER INGESTION EXPOSURE: Children (0-6 years old)

Chronic Daily Intake= (mg/kg-day) = Water Concentration X Ingestion Rate X Exposure Frequency X Exposure Duration X 1/Body Weight X 1/Averaging Time

mg/l X 0.7 l/day X 350 days/year X 6 years X 1/15 kg X 1/25550 days

Chemicals	Water Concentration	Ingestion Rate	Exposure Frequency	Exposure Duration	Body Weight	Averaging Time	Chronic Daily Intake (CDI)	Slope Factor (SF)	RISK = (CDI*SF)
1,1-Dichloroethene	4.40E-03	0.7	350	6	15	25550	1.7E-05	6.0E-01	1.0E-05
Tetrachloroethene	6.00E-02	0.7	350	6	15	25550	2.3E-04	5.2E-02	1.2E-05
Trichloroethene	3.03E-03	0.7	350	6	15	25550	1.2E-05	1.1E-02	1.3E-07
Vinyl Chloride	3.00E-03	0.7	350	6	15	25550	1.2E-05	1.9E+00	2.2E-05
Arsenic	2.70E-03	0.7	350	6	15	25550	1.0E-05	1.5E+00	1.6E-05
								TOTAL RISK =	6.0E-05

30-YEAR COMBINED RISK (ADULT + CHILD) = 9.8E-05

8/4/95
GW-INHCTC.XLS

TABLE D-2

CENTRAL TENDENCY CALCULATION
GROUNDWATER INHALATION PATHWAY (SHOWER MODEL)
SYOSSET LANDFILL SITE OU 2 - FUTURE-USE SCENARIO
RISKS TO SITE/AREA RESIDENTS

C(a) = Concentration of contaminant in air (mg/m3)
C(aMAX) = Maximum concentration of contaminant in air (mg/m3)
t1 = Time of shower (hr)
t2 = Time after shower (hr)

Equation:

	C(a) = (mg/m3)	[C(aMAX)/2 (mg/m3)	x	t1] (hr)	+ [C(aMAX) (mg/m3)	x	t2] (hr)	/	(t1 + t2) (hr)
Chemicals:									
1,1-Dichloroethene	2.1E-02	1.2E-02		0.12	2.5E-02		0.2		0.3
Tetrachloroethene	2.9E-01	1.7E-01		0.12	3.4E-01		0.2		0.3
Trichloroethene	1.5E-02	8.5E-03		0.12	1.7E-02		0.2		0.3
Vinyl Chloride	1.5E-02	8.4E-03		0.12	1.7E-02		0.2		0.3

C(aMAX) = Maximum air concentration in bathroom (mg/m3)
C(w) = Water concentration (mg/l)
f = Fraction volatilized (unitless)
F(w) = Water flow rate (l/hr)
V(a) = Bathroom volume (m3)

Equation:

	C(aMAX) = (mg/m3)	[C(w) (mg/l)	x	f (unitless)	x	F(w) (l/hr)	x	t1] (hr)	/	V(a) (m3)
Chemicals:										
1,1-Dichloroethene	2.5E-02	4.40E-03		0.75		750		0.12		12
Tetrachloroethene	3.4E-01	6.00E-02		0.75		750		0.12		12
Trichloroethene	1.7E-02	3.03E-03		0.75		750		0.12		12
Vinyl Chloride	1.7E-02	3.00E-03		0.75		750		0.12		12

8/4/95
GW-INHCTC.XLS

TABLE D-2

CENTRAL TENDENCY CALCULATION
GROUNDWATER INHALATION PATHWAY (SHOWER MODEL)
SYOSSET LANDFILL SITE OU 2 - FUTURE-USE SCENARIO
RISKS TO SITE/AREA RESIDENTS

CARCINOGENS - REASONABLE MAXIMUM CASE GROUNDWATER INHALATION EXPOSURE: Adults

Chronic Daily Intake= (mg/kg-day) = Air Concentration X Inhalation Rate X Exposure Time X Exposure Frequency X Exposure Duration X 1/Body Weight X 1/Averaging Time

mg/m3 X 0.6 m3/hr X 0.3 hr/day X 275 days/year X 9 years X 1/70 kg X 1/25550 days

Chemicals	Air Concentration	Inhalation Rate	Exposure Time	Exposure Frequency	Exposure Duration	Body Weight	Averaging Time	Chronic Daily Intake (CDI)	Slope Factor (SF)	RISK = (CDI*SF)
1,1-Dichloroethene	2.1E-02	0.6	0.3	275	9	70	25550	5.2E-06	1.2E+00	6.3E-06
Tetrachloroethene	2.9E-01	0.6	0.3	275	9	70	25550	7.2E-05	2.0E-03	1.4E-07
Trichloroethene	1.5E-02	0.6	0.3	275	9	70	25550	3.7E-06	6.0E-03	2.2E-08
Vinyl Chloride	1.5E-02	0.6	0.3	275	9	70	25550	3.7E-06	3.0E-01	1.1E-06
									TOTAL RISK =	7.6E-06

CARCINOGENS - REASONABLE MAXIMUM CASE GROUNDWATER INHALATION EXPOSURE: CHILDREN (0-6 years old)

Chronic Daily Intake= (mg/kg-day) = Air Concentration X Inhalation Rate X Exposure Time X Exposure Frequency X Exposure Duration X 1/Body Weight X 1/Averaging Time

mg/m3 X 0.6 m3/hr X 0.3 hr/day X 275 days/year X 6 years X 1/15 kg X 1/25550 days

Chemicals	Air Concentration	Inhalation Rate	Exposure Time	Exposure Frequency	Exposure Duration	Body Weight	Averaging Time	Chronic Daily Intake (CDI)	Slope Factor (SF)	RISK = (CDI*SF)
1,1-Dichloroethene	2.1E-02	0.6	0.3	275	6	15	25550	1.6E-05	1.2E+00	2.0E-05
Tetrachloroethene	2.9E-01	0.6	0.3	275	6	15	25550	2.2E-04	2.0E-03	4.5E-07
Trichloroethene	1.5E-02	0.6	0.3	275	6	15	25550	1.2E-05	6.0E-03	7.0E-08
Vinyl Chloride	1.5E-02	0.6	0.3	275	6	15	25550	1.2E-05	3.0E-01	3.5E-06
									TOTAL RISK =	2.4E-05

30-YEAR COMBINED RISK (ADULT + CHILD) = 3.1E-05

APPENDIX E

SITE DATA

SAMPLE NAME SAMPLE DATE		PK-10D-R1 11/04/93	PK-10D-R2 12/01/93	PK-10I-R1 11/04/93	PK-10I-R1-D 11/04/93	PK-10I-R1-AV 11/04/93	PK-10I-R2 12/01/93
Volatile Organics							
DICHLORODIFLUOROMETHANE	ug/l	1.00 UJ	1.00 U	1.00 UJ	1.00 UJ	1.00 UJ	1.00 U
CHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
VINYL CHLORIDE	ug/l	1.00 U	1.00 U	0.70 J	0.80 J	0.75 J	0.60 J
BROMOMETHANE	ug/l	1.00 UJ	1.00 U	1.00 UJ	1.00 UJ	1.00 UJ	1.00 U
CHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1-DICHLOROETHENE	ug/l	1.00 U	1.00 U	0.50 J	1.00 U	0.50 J	1.00 U
ACETONE	ug/l	16.00 UJ	25.00 UJ	29.00 UJ	26.00 UJ	27.50 UJ	23.00 UJ
CARBON DISULFIDE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
METHYLENE CHLORIDE	ug/l	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
1,2-TRANS-DICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1-DICHLOROETHANE	ug/l	0.40 J	0.50 J	6.60	6.30	6.45	5.40
2-BUTANONE	ug/l	R	R	R	R	R	R
CIS-1,2-DICHLOROETHENE	ug/l	0.40 J	0.30 J	2.70	2.50	2.60	1.30
CHLOROFORM	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1,1-TRICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
CARBON TETRACHLORIDE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
BENZENE	ug/l	0.40 J	1.00 U	0.50 J	0.50 J	0.50 J	1.00 U
1,2-DICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
TRICHLOROETHENE	ug/l	1.00 U	1.00 U	1.20	1.20	1.20	0.90 J
1,2-DICHLOROPROPANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
BROMODICHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
2-CHLOROETHYLVINYL ETHER	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
cis 1,3-DICHLOROPROPENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
4-METHYL-2-PENTANONE	ug/l	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
TOLUENE	ug/l	0.70 J	5.70	0.30 J	1.00 U	0.30 J	0.80 J
Trans 1,3-DICHLOROPROPENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1,2-TRICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
TETRACHLOROETHENE	ug/l	1.00 U	1.00 U	3.30	3.30	3.30	1.40
2-HEXANONE	ug/l	5.00 U	R	5.00 U	5.00 U	5.00 U	R
DIBROMOCHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
CHLOROBENZENE	ug/l	1.00 U	1.00 U	20.00	17.00	18.50	5.20
ETHYLBENZENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
META and/or PARA-XYLENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
ORTHO-XYLENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
STYRENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
BROMOFORM	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
TRICHLOROFLUOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1,2,2-TETRACHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U

SAMPLE NAME SAMPLE DATE		PK-10I-R2-D 12/01/93	PK-10I-R2-AV 12/01/93	PK-10S-R1 11/04/93	PK-10S-R2 12/01/93	RB-11D-R1 11/03/93	RB-11D-R2 11/30/93
Volatile Organics							
DICHLORODIFLUOROMETHANE	ug/l	0.20 J	0.20 J	1.00 UJ	0.20 J	1.00 U	1.00 UJ
CHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
VINYL CHLORIDE	ug/l	0.70 J	0.65 J	1.00 U	1.00 U	1.00 U	1.00 U
BROMOMETHANE	ug/l	1.00 U	1.00 U	1.00 UJ	1.00 U	1.00 U	1.00 U
CHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1-DICHLOROETHENE	ug/l	0.20 J	0.20 J	0.80 J	0.90 J	1.00 U	1.00 U
ACETONE	ug/l	30.00 UJ	26.50 UJ	14.00 UJ	18.00 UJ	R	38.00 UJ
CARBON DISULFIDE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 UJ
METHYLENE CHLORIDE	ug/l	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
1,2-TRANS-DICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1-DICHLOROETHANE	ug/l	5.60	5.50	5.40	6.70	1.00 U	1.00 U
2-BUTANONE	ug/l	R	R	R	R	R	R
CIS-1,2-DICHLOROETHENE	ug/l	1.40	1.35	1.00 U	1.00 U	1.00 U	1.00 U
CHLOROFORM	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1,1-TRICHLOROETHANE	ug/l	1.00 U	1.00 U	2.50	3.30	1.00 U	1.00 U
CARBON TETRACHLORIDE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
BENZENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-DICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
TRICHLOROETHENE	ug/l	0.90 J	0.90 J	0.50 J	0.70 J	1.00 U	1.00 U
1,2-DICHLOROPROPANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
BROMODICHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
2-CHLOROETHYLVINYL ETHER	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
cis 1,3-DICHLOROPROPENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
4-METHYL-2-PENTANONE	ug/l	1.00 U	3.00 U	5.00 U	5.00 U	5.00 U	5.00 U
TOLUENE	ug/l	1.00	0.90 J	0.30 J	0.80 J	1.20	0.40 J
Trans 1,3-DICHLOROPROPENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1,2-TRICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
TETRACHLOROETHENE	ug/l	1.50	1.45	1.30	1.30	1.00 U	1.00 U
2-HEXANONE	ug/l	R	R	5.00 U	R	5.00 U	R
DIBROMOCHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
CHLOROBENZENE	ug/l	5.30	5.25	1.00 U	1.00 U	1.00 U	1.00 U
ETHYLBENZENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
META and/or PARA-XYLENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	0.10 J	1.00 U
ORTHO-XYLENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
STYRENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
BROMOFORM	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
TRICHLOROFLUOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1,2,2-TETRACHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U

SAMPLE NAME SAMPLE DATE		RB-11I-R1 11/03/93	RB-11I-R1-D 11/03/93	RB-11I-R1-AV 11/03/93	RB-11I-R2 11/30/93	RB-11I-R2-D 11/30/93	RB-11I-R2-AV 11/30/93
Volatile Organics							
DICHLORODIFLUOROMETHANE	ug/l	1.60 J	1.60 J	1.60 J	2.60 J	2.70 J	2.65 J
CHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
VINYL CHLORIDE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
BROMOMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
CHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1-DICHLOROETHENE	ug/l	1.20	1.30	1.25	1.60	1.50	1.55
ACETONE	ug/l	19.00 UJ	14.00 UJ	16.50 UJ	64.00 UJ	46.00 UJ	55.00 UJ
CARBON DISULFIDE	ug/l	1.00 U	1.00 U	1.00 U	1.00 UJ	1.00 UJ	1.00 UJ
METHYLENE CHLORIDE	ug/l	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
1,2-TRANS-DICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1-DICHLOROETHANE	ug/l	10.00	10.00	10.00	13.00	13.00	13.00
2-BUTANONE	ug/l	R	R	R	R	R	R
CIS-1,2-DICHLOROETHENE	ug/l	2.80	2.90	2.85	2.10	2.20	2.15
CHLOROFORM	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1,1-TRICHLOROETHANE	ug/l	3.40	3.40	3.40	4.80	4.90	4.85
CARBON TETRACHLORIDE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
BENZENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-DICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
TRICHLOROETHENE	ug/l	3.00	3.00	3.00	3.90	4.00	3.95
1,2-DICHLOROPROPANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
BROMODICHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
2-CHLOROETHYLVINYL ETHER	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
cis 1,3-DICHLOROPROPENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
4-METHYL-2-PENTANONE	ug/l	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
TOLUENE	ug/l	0.60 J	0.60 J	0.60 J	0.30 J	0.30 J	0.30 J
Trans 1,3-DICHLOROPROPENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1,2-TRICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
TETRACHLOROETHENE	ug/l	19.00	19.00	19.00	23.00	23.00	23.00
2-HEXANONE	ug/l	5.00 U	5.00 U	5.00 U	R	R	R
DIBROMOCHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
CHLOROBENZENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
ETHYLBENZENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
META and/or PARA-XYLENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
ORTHO-XYLENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
STYRENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
BROMOFORM	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
TRICHLOROFLUOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	0.90 J	0.90 J	0.90 J
1,1,2,2-TETRACHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U

SAMPLE NAME SAMPLE DATE		RB-11S-R1 11/03/93	RB-11S-R2 11/30/93	RW-12D-R1 11/05/93	RW-12D-R2 12/02/93	RW-12I-R1 11/05/93	RW-12I-R1-D 11/05/93
Volatile Organics							
DICHLORODIFLUOROMETHANE	ug/l	1.00 U	1.00 UJ	1.00 U	1.00 U	2.00 U	2.00 U
CHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	2.00 U	2.00 U
VINYL CHLORIDE	ug/l	1.00 U	1.00 U	9.20	17.00	2.00 U	2.00 U
BROMOMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 UJ	2.00 U	2.00 U
CHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 UJ	2.00 U	2.00 U
1,1-DICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	13.00	15.00
ACETONE	ug/l	35.00 UJ	56.00 UJ	29.00 UJ	21.00 UJ	R	R
CARBON DISULFIDE	ug/l	1.00 U	1.00 UJ	1.00 UJ	1.00 UJ	2.00 UJ	2.00 UJ
METHYLENE CHLORIDE	ug/l	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	4.00 U
1,2-TRANS-DICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	2.00 U	2.00 U
1,1-DICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	0.30 J	11.00	13.00
2-BUTANONE	ug/l	R	R	R	R	R	R
CIS-1,2-DICHLOROETHENE	ug/l	1.00 U	1.00 U	2.60	2.30	5.20	5.70
CHLOROFORM	ug/l	1.00 U	1.00 U	1.30 U	1.40 U	2.00 U	2.00 U
1,1,1-TRICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	40.00	40.00
CARBON TETRACHLORIDE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	2.00 U	2.00 U
BENZENE	ug/l	1.00 U	1.00 U	0.40 J	0.90 J	2.00 U	2.00 U
1,2-DICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.80 U	2.00 U	2.00 U
TRICHLOROETHENE	ug/l	1.00 U	1.00 U	0.90 J	1.10	6.20	6.30
1,2-DICHLOROPROPANE	ug/l	1.00 U	1.00 U	1.00 U	1.00	2.00 U	2.00 U
BROMODICHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	2.00 U	2.00 U
2-CHLOROETHYLVINYL ETHER	ug/l	1.00 U	1.00 U	1.00 UJ	1.00 U	2.00 UJ	2.00 UJ
cis 1,3-DICHLOROPROPENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	2.00 U	2.00 U
4-METHYL-2-PENTANONE	ug/l	5.00 U	5.00 U	5.00 U	5.00 U	10.00 U	10.00 U
TOLUENE	ug/l	1.00 U	0.80 J	0.70 J	6.60	2.00 U	2.00 U
Trans 1,3-DICHLOROPROPENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	2.00 U	2.00 U
1,1,2-TRICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	2.00 U	2.00 U
TETRACHLOROETHENE	ug/l	1.00 U	1.00 U	2.60	2.40	68.00	71.00
2-HEXANONE	ug/l	5.00 U	R	R	R	R	R
DIBROMOCHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	2.00 U	2.00 U
CHLOROBENZENE	ug/l	1.00 U	1.00 U	1.00 U	0.30 J	1.10 J	1.30 J
ETHYLBENZENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	2.00 U	2.00 U
META and/or PARA-XYLENE	ug/l	1.00 U	0.10 J	1.00 U	1.00 U	2.00 U	2.00 U
ORTHO-XYLENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	2.00 U	2.00 U
STYRENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	2.00 U	2.00 U
BROMOFORM	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	2.00 U	2.00 U
TRICHLOROFLUOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	2.00 U	2.00 U
1,1,2,2-TETRACHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	2.00 U	2.00 U

SAMPLE NAME SAMPLE DATE		RW-12I-R1-AV 11/05/93	RW-12I-R2 12/02/93	RW-12I-R2-D 12/02/93	RW-12I-R2-AV 12/02/93	SY-3DD-R1 11/01/93	SY-3DD-R2 11/29/93
Volatile Organics							
DICHLORODIFLUOROMETHANE	ug/l	2.00 U	5.00 U	5.00 U	5.00 U	1.00 U	1.00 U
CHLOROMETHANE	ug/l	2.00 U	5.00 U	5.00 U	5.00 U	1.00 UJ	1.00 U
VINYL CHLORIDE	ug/l	2.00 U	0.60 J	5.00 U	0.60 J	1.00 U	1.00 U
BROMOMETHANE	ug/l	2.00 U	5.00 U	5.00 U	5.00 U	1.00 UJ	1.00 U
CHLOROETHANE	ug/l	2.00 U	5.00 U	5.00 U	5.00 U	1.00 U	1.00 U
1,1-DICHLOROETHENE	ug/l	14.00	26.00	27.00	26.50	1.00 U	1.00 U
ACETONE	ug/l	R	130.00 UJ	130.00 UJ	130.00 UJ	29.00 UJ	52.00 UJ
CARBON DISULFIDE	ug/l	2.00 UJ	5.00 UJ	5.00 UJ	5.00 UJ	1.00 U	1.00 UJ
METHYLENE CHLORIDE	ug/l	3.00 U	10.00 U	12.00 U	11.00 U	2.00 U	2.00 U
1,2-TRANS-DICHLOROETHENE	ug/l	2.00 U	5.00 U	5.00 U	5.00 U	1.00 U	1.00 U
1,1-DICHLOROETHANE	ug/l	12.00	17.00	17.00	17.00	1.00 U	1.00 U
2-BUTANONE	ug/l	R	R	R	R	R	R
CIS-1,2-DICHLOROETHENE	ug/l	5.45	5.70	5.90	5.80	1.00 U	1.00 U
CHLOROFORM	ug/l	2.00 U	5.00 U	5.00 U	5.00 U	1.00 U	1.00 U
1,1,1-TRICHLOROETHANE	ug/l	40.00	75.00	75.00	75.00	1.00 U	1.00 U
CARBON TETRACHLORIDE	ug/l	2.00 U	5.00 U	5.00 U	5.00 U	1.00 U	1.00 U
BENZENE	ug/l	2.00 U	0.50 J	0.50 J	0.50 J	1.00 U	1.00 U
1,2-DICHLOROETHANE	ug/l	2.00 U	5.00 U	5.00 U	5.00 U	1.00 U	1.00 U
TRICHLOROETHENE	ug/l	6.25	9.80	9.90	9.85	1.00 U	1.00 U
1,2-DICHLOROPROPANE	ug/l	2.00 U	5.00 U	5.00 U	5.00 U	1.00 U	1.00 U
BROMODICHLOROMETHANE	ug/l	2.00 U	5.00 U	5.00 U	5.00 U	1.00 U	1.00 U
2-CHLOROETHYLVINYL ETHER	ug/l	2.00 UJ	5.00 U	5.00 U	5.00 U	1.00 U	1.00 U
cis 1,3-DICHLOROPROPENE	ug/l	2.00 U	5.00 U	5.00 U	5.00 U	1.00 U	1.00 U
4-METHYL-2-PENTANONE	ug/l	10.00 U	25.00 U	25.00 U	25.00 U	5.00 U	5.00 U
TOLUENE	ug/l	2.00 U	13.00	12.00	12.50	1.00 U	1.00 U
Trans 1,3-DICHLOROPROPENE	ug/l	2.00 U	5.00 U	5.00 U	5.00 U	1.00 U	1.00 U
1,1,2-TRICHLOROETHANE	ug/l	2.00 U	5.00 U	5.00 U	5.00 U	1.00 U	1.00 U
TETRACHLOROETHENE	ug/l	69.50	110.00	110.00	110.00	1.00 U	1.00 U
2-HEXANONE	ug/l	R	R	R	R	R	R
DIBROMOCHLOROMETHANE	ug/l	2.00 U	5.00 U	5.00 U	5.00 U	1.00 U	1.00 U
CHLOROBENZENE	ug/l	1.20 J	0.90 J	0.90 J	0.90 J	1.00 U	1.00 U
ETHYLBENZENE	ug/l	2.00 U	5.00 U	5.00 U	5.00 U	1.00 U	1.00 U
META and/or PARA-XYLENE	ug/l	2.00 U	5.00 U	5.00 U	5.00 U	1.00 U	1.00 U
ORTHO-XYLENE	ug/l	2.00 U	5.00 U	5.00 U	5.00 U	1.00 U	1.00 U
STYRENE	ug/l	2.00 U	5.00 U	5.00 U	5.00 U	1.00 U	1.00 U
BROMOFORM	ug/l	2.00 U	5.00 U	5.00 U	5.00 U	1.00 U	1.00 U
TRICHLOROFLUOROMETHANE	ug/l	2.00 U	1.20 J	1.20 J	1.20 J	1.00 U	1.00 U
1,1,2,2-TETRACHLOROETHANE	ug/l	2.00 U	5.00 U	5.00 U	5.00 U	1.00 U	1.00 U

SAMPLE NAME SAMPLE DATE		PK-10D-R1 11/04/93	PK-10D-R2 12/01/93	PK-10I-R1 11/04/93	PK-10I-R1-D 11/04/93	PK-10I-R1-AV 11/04/93	PK-10I-R2 12/01/93
Inorganics							
ALUMINUM	ug/l	NA	NA	NA	NA	NA	NA
ANTIMONY	ug/l	21.00 U	21.00 U	21.00 U	21.00 U	21.00 U	21.00 U
ARSENIC	ug/l	9.70 B	6.30 B	1.00 U	1.00 U	1.00 U	1.00 UJ
BARIUM	ug/l	3.00 B	4.20 B	54.80 B	60.80 B	57.80 B	65.40 BJ
BERYLLIUM	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
CADMIUM	ug/l	2.00 U	2.00 B	2.00 U	2.00 U	2.00 U	2.00 U
CALCIUM	ug/l	NA	NA	NA	NA	NA	NA
CHROMIUM	ug/l	9.40 B	3.50 BJ	3.00 U	3.00 U	3.00 U	3.70 B
COBALT	ug/l	NA	NA	NA	NA	NA	NA
COPPER	ug/l	7.00 U	7.00 U	9.90 B	13.00 B	11.50 B	7.00 U
IRON	ug/l	R	179.00	R	R	R	474.00
LEAD	ug/l	3.40 J	1.70 BJ	3.80 J	3.80 J	3.80 J	3.20
MAGNESIUM	ug/l	NA	NA	NA	NA	NA	NA
MANGANESE	ug/l	NA	NA	NA	NA	NA	NA
MERCURY	ug/l	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	ug/l	11.00 U	11.00 U	11.00 U	11.00 U	11.00 U	16.40 B
POTASSIUM	ug/l	473.00 U	853.00 B	46,100.00	50,600.00	48,350.00	53,400.00
SELENIUM	ug/l	2.00 UJ	2.00 U	2.00 UJ	2.00 UJ	2.00 UJ	2.00 UJ
SILVER	ug/l	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
SODIUM	ug/l	22,900.00	15,900.00	176,000.00	193,000.00	184,500.00	235,000.00 J
THALLIUM	ug/l	1.00 UJ	1.00 UJ	1.00 UJ	1.00 UJ	1.00 UJ	1.00 UJ
VANADIUM	ug/l	NA	NA	NA	NA	NA	NA
ZINC	ug/l	64.80 J	53.60 J	58.70 J	75.80 J	67.30 J	42.60
CYANIDE	ug/l	NA	NA	NA	NA	NA	NA

SAMPLE NAME SAMPLE DATE		PK-10I-R2-D 12/01/93	PK-10I-R2-AV 12/01/93	PK-10S-R1 11/04/93	PK-10S-R2 12/01/93	RB-11D-R1 11/03/93	RB-11D-R2 11/30/93
Inorganics							
ALUMINUM	ug/l	NA	NA	NA	NA	NA	NA
ANTIMONY	ug/l	21.00 U	21.00 U	21.00 U	21.00 U	21.00 U	21.00 U
ARSENIC	ug/l	1.00 UJ	1.00 UJ	1.90 B	3.50 BJ	1.00 UJ	1.00 UJ
BARIUM	ug/l	65.40 BJ	65.40 BJ	38.50 B	36.30 BJ	9.40 B	6.90 B
BERYLLIUM	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
CADMIUM	ug/l	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
CALCIUM	ug/l	NA	NA	NA	NA	NA	NA
CHROMIUM	ug/l	4.60 B	4.15 B	3.00 U	3.00 U	3.00 U	9.80 B
COBALT	ug/l	NA	NA	NA	NA	NA	NA
COPPER	ug/l	7.00 U	7.00 U	38.80	8.10 B	13.90 B	7.00 U
IRON	ug/l	473.00	473.50	R	5,380.00	975.00	958.00
LEAD	ug/l	3.30	3.25	10.10 J	6.20	4.60	3.00
MAGNESIUM	ug/l	NA	NA	NA	NA	NA	NA
MANGANESE	ug/l	NA	NA	NA	NA	NA	NA
MERCURY	ug/l	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	ug/l	16.80 B	16.60 B	25.00 B	17.50 B	11.00 U	17.80 B
POTASSIUM	ug/l	53,500.00	53,450.00	1,010.00 B	1,900.00 B	473.00 U	787.00 B
SELENIUM	ug/l	2.00 UJ	2.00 UJ	2.00 UJ	2.00 UJ	2.00 UJ	2.00 UJ
SILVER	ug/l	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
SODIUM	ug/l	237,000.00 J	236,000.00 J	19,400.00	20,500.00	4,260.00 B	4,220.00 B
THALLIUM	ug/l	1.00 UJ	1.00 UJ	1.00 UJ	1.00 UJ	1.00 U	1.00 UJ
VANADIUM	ug/l	NA	NA	NA	NA	NA	NA
ZINC	ug/l	40.80	41.70	178.00 J	43.30 J	41.20	R
CYANIDE	ug/l	NA	NA	NA	NA	NA	NA

SAMPLE NAME SAMPLE DATE		RB-11I-R1 11/03/93	RB-11I-R1-D 11/03/93	RB-11I-R1-AV 11/03/93	RB-11I-R2 11/30/93	RB-11I-R2-D 11/30/93	RB-11I-R2-AV 11/30/93
Inorganics							
ALUMINUM	ug/l	NA	NA	NA	NA	NA	NA
ANTIMONY	ug/l	21.00 U	21.00 U	21.00 U	21.00 U	21.00 U	21.00 U
ARSENIC	ug/l	1.00 UJ	1.00 UJ	1.00 UJ	1.00 UJ	1.00 UJ	1.00 UJ
BARIUM	ug/l	56.20 B	58.40 B	57.30 B	67.20 BJ	66.60 BJ	66.90 BJ
BERYLLIUM	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
CADMIUM	ug/l	2.00 BJ	3.70 BJ	2.90 BJ	2.00 U	2.00 U	2.00 U
CALCIUM	ug/l	NA	NA	NA	NA	NA	NA
CHROMIUM	ug/l	15.50	14.00	14.80	3.00 U	3.00 U	3.00 U
COBALT	ug/l	NA	NA	NA	NA	NA	NA
COPPER	ug/l	15.10 B	12.60 B	13.90 B	7.00 U	7.00 U	7.00 U
IRON	ug/l	959.00	792.00	875.50	881.00	759.00	820.00
LEAD	ug/l	4.90	4.40	4.70	4.20	4.20	4.20
MAGNESIUM	ug/l	NA	NA	NA	NA	NA	NA
MANGANESE	ug/l	NA	NA	NA	NA	NA	NA
MERCURY	ug/l	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	ug/l	11.00 U	14.60 B	10.10 B	21.80 B	14.60 B	18.20 B
POTASSIUM	ug/l	1,320.00 B	1,260.00 B	1,290.00 B	1,620.00 B	1,560.00 B	1,590.00 B
SELENIUM	ug/l	2.00 UJ	2.00 UJ	2.00 UJ	2.00 UJ	2.00 UJ	2.00 UJ
SILVER	ug/l	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
SODIUM	ug/l	17,400.00	18,200.00	17,800.00	18,500.00	18,700.00	18,600.00
THALLIUM	ug/l	1.00 U	1.00 U	1.00 U	1.00 UJ	1.00 UJ	1.00 UJ
VANADIUM	ug/l	NA	NA	NA	NA	NA	NA
ZINC	ug/l	66.90	66.10	66.50	48.60	41.20 J	44.90 J
CYANIDE	ug/l	NA	NA	NA	NA	NA	NA

SAMPLE NAME		RB-11S-R1	RB-11S-R2	RW-12D-R1	RW-12D-R2	RW-12I-R1	RW-12I-R1-D
SAMPLE DATE		11/03/93	11/30/93	11/05/93	12/02/93	11/05/93	11/05/93
Inorganics							
ALUMINUM	ug/l	NA	NA	NA	NA	NA	NA
ANTIMONY	ug/l	21.00 U	21.00 U	21.00 U	21.00 U	21.00 U	21.00 U
ARSENIC	ug/l	1.00 UJ	1.00 UJ	1.00 U	1.00 U	1.00 U	1.00 U
BARIUM	ug/l	8.60 B	8.10 B	46.90 B	75.20 B	46.90 B	46.90 B
BERYLLIUM	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
CADMIUM	ug/l	2.80 BJ	2.00 U	2.00 U	2.40 B	2.00 U	2.00 U
CALCIUM	ug/l	NA	NA	NA	NA	NA	NA
CHROMIUM	ug/l	3.00 U	8.60 B	11.90	3.00 UJ	6.80 B	5.50 B
COBALT	ug/l	NA	NA	NA	NA	NA	NA
COPPER	ug/l	13.90 B	7.00 U	7.00 U	7.00 B	7.00 U	7.00 U
IRON	ug/l	1,130.00	1,270.00	R	552.00	R	R
LEAD	ug/l	2.60 B	3.70	7.10 J	7.10 J	4.50 J	2.30 BJ
MAGNESIUM	ug/l	NA	NA	NA	NA	NA	NA
MANGANESE	ug/l	NA	NA	NA	NA	NA	NA
MERCURY	ug/l	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	ug/l	11.00 U	18.20 B	11.00 U	11.00 U	11.00 U	11.00 U
POTASSIUM	ug/l	1,140.00 B	1,510.00 B	1,880.00 B	1,850.00 B	8,100.00 J	8,110.00 J
SELENIUM	ug/l	2.00 UJ	2.00 UJ	8.40 BJ	5.40	2.00 UJ	2.00 UJ
SILVER	ug/l	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
SODIUM	ug/l	7,590.00	7,920.00	55,700.00	66,500.00	53,500.00 J	52,100.00 J
THALLIUM	ug/l	1.00 U	1.00 UJ	1.00 UJ	1.00 UJ	1.00 UJ	1.00 UJ
VANADIUM	ug/l	NA	NA	NA	NA	NA	NA
ZINC	ug/l	30.40	53.10	77.40 J	85.60 J	57.70 J	57.10 J
CYANIDE	ug/l	NA	NA	NA	NA	NA	NA

SAMPLE NAME SAMPLE DATE		RW-12I-R1-AV 11/05/93	RW-12I-R2 12/02/93	RW-12I-R2-D 12/02/93	RW-12I-R2-AV 12/02/93	SY-3DD-R1 11/01/93	SY-3DD-R2 11/29/93
Inorganics							
ALUMINUM	ug/l	NA	NA	NA	NA	NA	NA
ANTIMONY	ug/l	21.00 U	21.00 U	21.00 U	21.00 U	25.00 B	21.00 U
ARSENIC	ug/l	1.00 U	1.50 B	1.40 B	1.50 B	1.00 UJ	1.00 UJ
BARIUM	ug/l	46.90 B	54.00 B	55.10 B	54.60 B	2.00 U	2.50 B
BERYLLIUM	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
CADMIUM	ug/l	2.00 U	2.00 U	3.30 B	2.20 B	2.00 U	2.00 U
CALCIUM	ug/l	NA	NA	NA	NA	NA	NA
CHROMIUM	ug/l	6.20 B	3.00 UJ	3.00 UJ	3.00 UJ	3.00 U	9.40 B
COBALT	ug/l	NA	NA	NA	NA	NA	NA
COPPER	ug/l	7.00 U	7.00 U	7.00 U	7.00 U	R	20.10 B
IRON	ug/l	R	320.00	342.00	331.00	1,030.00	564.00
LEAD	ug/l	3.40 BJ	2.80 BJ	3.30 J	3.10 BJ	7.50	2.70 B
MAGNESIUM	ug/l	NA	NA	NA	NA	NA	NA
MANGANESE	ug/l	NA	NA	NA	NA	NA	NA
MERCURY	ug/l	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	ug/l	11.00 U	11.00 U	11.00 U	11.00 U	14.60 B	34.20 B
POTASSIUM	ug/l	8,105.00 J	10,300.00	10,300.00	10,300.00	869.00 B	823.00 B
SELENIUM	ug/l	2.00 UJ	2.00 U	2.00 U	2.00 U	2.00 UJ	2.00 UJ
SILVER	ug/l	2.00 U	2.00 U	2.00 U	2.00 U	2.30 B	2.00 U
SODIUM	ug/l	52,800.00 J	60,800.00	62,000.00	61,400.00	7,530.00	4,760.00 B
THALLIUM	ug/l	1.00 UJ	1.00 UJ	1.00 UJ	1.00 UJ	1.00 UJ	1.00 UJ
VANADIUM	ug/l	NA	NA	NA	NA	NA	NA
ZINC	ug/l	57.40 J	48.90 J	58.90 J	53.90 J	160.00	R
CYANIDE	ug/l	NA	NA	NA	NA	NA	NA

SAMPLE NAME SAMPLE DATE		TB-11/01/93 11/01/93	TB-11/02/93 11/02/93	TB-11/03/93 11/03/93	TB-11/04/93 11/04/93	TB-11/05/93 11/05/93	TB-11/29/93 11/29/93
Volatile Organics							
DICHLORODIFLUOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 UJ	1.00 UJ	0.40 J
CHLOROMETHANE	ug/l	1.00 UJ	1.00 UJ	1.00 U	1.00 U	1.00 U	1.00 U
VINYL CHLORIDE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
BROMOMETHANE	ug/l	1.00 UJ	1.00 UJ	1.00 U	1.00 UJ	1.00 U	1.00 U
CHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1-DICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
ACETONE	ug/l	28.00 JB	34.00 JB	14.00 JB	14.00 J	35.00 J	33.00 J
CARBON DISULFIDE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 UJ
METHYLENE CHLORIDE	ug/l	2.80 JB	1.00 JB	0.40 JB	0.40 JB	0.50 JB	2.70 JB
1,2-TRANS-DICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1-DICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
2-BUTANONE	ug/l	R	R	R	R	R	R
CIS-1,2-DICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
CHLOROFORM	ug/l	0.90 J	1.10	0.80 J	1.00 B	0.80 JB	0.80 JB
1,1,1-TRICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
CARBON TETRACHLORIDE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
BENZENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-DICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
TRICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-DICHLOROPROPANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
BROMODICHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
2-CHLOROETHYLVINYL ETHER	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
cis 1,3-DICHLOROPROPENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
4-METHYL-2-PENTANONE	ug/l	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
TOLUENE	ug/l	0.20 J	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Trans 1,3-DICHLOROPROPENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1,2-TRICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
TETRACHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
2-HEXANONE	ug/l	R	R	5.00 U	5.00 U	5.00 U	R
DIBROMOCHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
CHLOROBENZENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
ETHYLBENZENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
META and/or PARA-XYLENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
ORTHO-XYLENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
STYRENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
BROMOFORM	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 UJ	1.00 U
TRICHLOROFLUOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	0.40 J
1,1,2,2-TETRACHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U

SAMPLE NAME SAMPLE DATE		TB-11/30/93 11/30/93	TB-12/01/93 12/01/93	TB-12/02/93 12/02/93	TB-12/03/93 12/03/93
Volatile Organics					
DICHLORODIFLUOROMETHANE	ug/l	0.40 J	1.00 U	1.00 U	1.00 U
CHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
VINYL CHLORIDE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
BROMOMETHANE	ug/l	1.00 U	1.00 U	1.00 UJ	1.00 U
CHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 UJ	1.00 U
1,1-DICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
ACETONE	ug/l	30.00 J	14.00 JB	24.00 J	50.00 JB
CARBON DISULFIDE	ug/l	1.00 UJ	1.00 U	1.00 UJ	1.00 U
METHYLENE CHLORIDE	ug/l	0.50 JB	0.80 JB	0.70 JB	0.70 JB
1,2-TRANS-DICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
1,1-DICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
2-BUTANONE	ug/l	R	R	R	R
CIS-1,2-DICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
CHLOROFORM	ug/l	1.20 B	1.00 B	0.90 JB	0.90 JB
1,1,1-TRICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
CARBON TETRACHLORIDE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
BENZENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
1,2-DICHLOROETHANE	ug/l	1.00	1.00 U	0.80 J	1.50
TRICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
1,2-DICHLOROPROPANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
BROMODICHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
2-CHLOROETHYLVINYL ETHER	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
cis 1,3-DICHLOROPROPENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
4-METHYL-2-PENTANONE	ug/l	5.00 U	5.00 U	5.00 U	5.00 U
TOLUENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
Trans 1,3-DICHLOROPROPENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
1,1,2-TRICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
TETRACHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
2-HEXANONE	ug/l	R	R	R	R
DIBROMOCHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
CHLOROBENZENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
ETHYLBENZENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
META and/or PARA-XYLENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
ORTHO-XYLENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
STYRENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
BROMOFORM	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
TRICHLOROFLUOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
1,1,2,2-TETRACHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U

SAMPLE NAME SAMPLE DATE		FB-11/01/93 11/01/93	FB-11/02/93 11/02/93	FB-11/03/93 11/03/93	FB-11/04/93 11/04/93	FB-11/05/93 11/05/93	FB-11/29/93 11/29/93
Volatile Organics							
DICHLORODIFLUOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 J	1.00 UJ	0.40 J
CHLOROMETHANE	ug/l	1.00 UJ	1.00 UJ	1.00 U	0.40 J	1.00 U	1.00 U
VINYL CHLORIDE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
BROMOMETHANE	ug/l	1.00 UJ	1.00 UJ	1.00 U	1.00 UJ	1.00 U	1.00 U
CHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1-DICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
ACETONE	ug/l	19.00 JB	21.00 JB	12.00 JB	55.00 J	29.00 J	32.00 J
CARBON DISULFIDE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 UJ
METHYLENE CHLORIDE	ug/l	4.30 JB	0.80 JB	0.50 JB	0.30 JB	0.50 JB	2.70 BJ
1,2-TRANS-DICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1-DICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
2-BUTANONE	ug/l	R	R	R	R	R	R
CIS-1,2-DICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
CHLOROFORM	ug/l	1.10	1.10	0.90 J	1.20 B	1.00 B	0.70 JB
1,1,1-TRICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
CARBON TETRACHLORIDE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
BENZENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-DICHLOROETHANE	ug/l	1.00 U	0.40 J	1.00 U	0.40 J	1.00 U	0.80 J
TRICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-DICHLOROPROPANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
BROMODICHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
2-CHLOROETHYLVINYL ETHER	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
cis 1,3-DICHLOROPROPENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
4-METHYL-2-PENTANONE	ug/l	5.00 U	5.00 U	5.00 U	5.30	5.00 U	5.00 U
TOLUENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Trans 1,3-DICHLOROPROPENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1,2-TRICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
TETRACHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
2-HEXANONE	ug/l	R	R	5.00 U	5.00 U	5.00 U	R
DIBROMOCHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
CHLOROBENZENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
ETHYLBENZENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
META and/or PARA-XYLENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
ORTHO-XYLENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
STYRENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
BROMOFORM	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 UJ	1.00 U
TRICHLOROFLUOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	0.20 J
1,1,2,2-TETRACHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	0.60 J	1.00 U	1.00 U

SAMPLE NAME SAMPLE DATE		FB-11/30/93 11/30/93	FB-12/01/93 12/01/93	FB-12/02/93 12/02/93	FB-12/03/93 12/03/93
Volatile Organics					
DICHLORODIFLUOROMETHANE	ug/l	0.40 J	1.00 U	1.00 U	1.00 U
CHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
VINYL CHLORIDE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
BROMOMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
CHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
1,1-DICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
ACETONE	ug/l	44.00 J	31.00 JB	34.00 JB	34.00 JB
CARBON DISULFIDE	ug/l	1.00 UJ	1.00 U	1.00 U	1.00 U
METHYLENE CHLORIDE	ug/l	2.80 JB	2.10 JB	2.40 JB	2.10 B
1,2-TRANS-DICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
1,1-DICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
2-BUTANONE	ug/l	R	R	R	R
CIS-1,2-DICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
CHLOROFORM	ug/l	0.70 JB	0.80 JB	0.90 JB	0.80 JB
1,1,1-TRICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
CARBON TETRACHLORIDE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
BENZENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
1,2-DICHLOROETHANE	ug/l	1.20	0.80 J	0.50 J	1.00 U
TRICHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
1,2-DICHLOROPROPANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
BROMODICHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
2-CHLOROETHYLVINYL ETHER	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
cis 1,3-DICHLOROPROPENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
4-METHYL-2-PENTANONE	ug/l	5.00 U	5.00 U	5.00 U	5.00 U
TOLUENE	ug/l	1.00 U	1.00 U	0.20 J	1.00 U
Trans 1,3-DICHLOROPROPENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
1,1,2-TRICHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
TETRACHLOROETHENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
2-HEXANONE	ug/l	R	R	R	R
DIBROMOCHLOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
CHLOROBENZENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
ETHYLBENZENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
META and/or PARA-XYLENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
ORTHO-XYLENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
STYRENE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
BROMOFORM	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
TRICHLOROFLUOROMETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
1,1,2,2-TETRACHLOROETHANE	ug/l	1.00 U	1.00 U	1.00 U	1.00 U

SYOSSET LANDFILL OU 2
FIELD BLANKS

07/13/1995
10:29 AM

SAMPLE NAME SAMPLE DATE		FB-11/01/93 11/01/93	FB-11/02/93 11/02/93	FB-11/03/93 11/03/93	FB-11/04/93 11/04/93	FB-11/05/93 11/05/93	FB-11/29/93 11/29/93
Inorganics							
ALUMINUM	ug/l	NA	NA	NA	NA	NA	NA
ANTIMONY	ug/l	21.10 B	26.60 B	21.00 U	21.00 U	21.00 U	21.00 U
ARSENIC	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 UJ
BARIUM	ug/l	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
BERYLLIUM	ug/l	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
CADMIUM	ug/l	2.00 U	2.70 BJ	2.80 BJ	2.00 U	2.00 U	2.00 U
CALCIUM	ug/l	NA	NA	NA	NA	NA	NA
CHROMIUM	ug/l	3.00 U	3.00 U	4.20 B	3.00 U	3.00 U	3.70 B
COBALT	ug/l	NA	NA	NA	NA	NA	NA
COPPER	ug/l	28.60	16.30 B	7.00 U	8.60 B	7.00 U	19.80 B
IRON	ug/l	87.00 U	87.00 U	87.00 U	87.00 U	87.00 U	87.00 U
LEAD	ug/l	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 UJ
MAGNESIUM	ug/l	NA	NA	NA	NA	NA	NA
MANGANESE	ug/l	NA	NA	NA	NA	NA	NA
MERCURY	ug/l	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	ug/l	11.00 U	11.00 U	11.00 U	11.00 U	11.00 U	13.50 B
POTASSIUM	ug/l	473.00 U	473.00 U	473.00 U	473.00 U	473.00 U	671.00 B
SELENIUM	ug/l	2.00 U	2.00 U	2.00 U	2.00 UJ	2.00 UJ	2.00 UJ
SILVER	ug/l	2.10 B	3.10 B	2.00 U	2.00 U	2.00 U	2.00 U
SODIUM	ug/l	121.00 U	121.00 U	121.00 U	121.00 U	121.00 U	121.00 U
THALLIUM	ug/l	1.00 UJ	1.00 UJ	1.00 U	1.00 UJ	1.00 UJ	1.00 UJ
VANADIUM	ug/l	NA	NA	NA	NA	NA	NA
ZINC	ug/l	R	14.60 B	4.00 U	5.70 B	15.40 B	32.70
CYANIDE	ug/l	NA	NA	NA	NA	NA	NA

SAMPLE NAME SAMPLE DATE		FB-11/30/93 11/30/93	FB-12/01/93 12/01/93	FB-12/02/93 12/02/93	FB-12/03/93 12/03/93
Inorganics					
ALUMINUM	ug/l	NA	NA	NA	NA
ANTIMONY	ug/l	21.00 U	21.00 U	21.00 U	21.00 U
ARSENIC	ug/l	1.00 UJ	1.00 UJ	1.00 UJ	1.00 U
BARIUM	ug/l	2.00 U	2.00 U	2.00 U	2.00 U
BERYLLIUM	ug/l	1.00 U	1.00 U	1.00 U	1.00 U
CADMIUM	ug/l	2.00 U	2.00 U	2.00 U	2.20 B
CALCIUM	ug/l	NA	NA	NA	NA
CHROMIUM	ug/l	3.00 U	6.10 B	3.00 U	3.00 UJ
COBALT	ug/l	NA	NA	NA	NA
COPPER	ug/l	7.00 U	7.00 U	7.00 U	7.00 U
IRON	ug/l	87.00 U	87.00 U	87.00 U	489.00
LEAD	ug/l	2.00 U	2.00 U	2.00 UJ	1.00 UJ
MAGNESIUM	ug/l	NA	NA	NA	NA
MANGANESE	ug/l	NA	NA	NA	NA
MERCURY	ug/l	0.20 U	0.20 U	0.20 U	0.20 U
NICKEL	ug/l	13.20 B	11.00 U	11.00 U	11.00 U
POTASSIUM	ug/l	473.00 U	473.00 U	473.00 U	473.00 U
SELENIUM	ug/l	2.00 UJ	2.00 UJ	2.00 U	2.00 U
SILVER	ug/l	2.00 U	2.00 U	2.00 U	2.00 U
SODIUM	ug/l	121.00 U	126.00 B	191.00 B	272.00 B
THALLIUM	ug/l	1.00 UJ	1.00 U	1.00 UJ	1.00 UJ
VANADIUM	ug/l	NA	NA	NA	NA
ZINC	ug/l	10.00 B	10.10 B	11.80 B	16.90 BJ
CYANIDE	ug/l	NA	NA	NA	NA

APPENDIX F
ROUND 3 SITE DATA

IEA
An Aquarion Company

200 Monroe Turnpike
Monroe, Connecticut 06468

Phone 203-261-4458
Fax 203-268-5346

August 28, 1995

Mr. Michael Wolfert
Geraghty & Miller
125 East Bethpage Road
Plainview, NY 11803

Dear Mr. Wolfert:

Please find enclosed the analytical results of 12 samples received at our laboratory on July 28 and 29, 1995. This report contains sections addressing the following information at a minimum:

- sample summary
- analytical methodology
- state certifications
- definitions of data qualifiers and terminology
- analytical results
- chain-of-custody

IEA Report #3095-1016	Purchase Order #NY0029008
Project ID: SYOSETT LANDFILL	

Copies of this analytical report and supporting data are maintained in our files for a minimum of five years unless special arrangements have been made. Unless specifically indicated, all analytical testing was performed at this laboratory location and no portion of the testing was subcontracted.

We appreciate your selection of our services and welcome any questions or suggestions you may have relative to this report. Please contact your customer service representative at (203) 261-4458 for any additional information. Thank you for utilizing our services; we hope you will consider us for your future analytical needs.

I have reviewed and approved the enclosed data for final release.

Very truly yours,

Jeffrey C. Curran
Laboratory Manager

JCC/adj

3095-1016
GERAGHTY & MILLER
PROJECT SUMMARY

The samples were analyzed for the parameters listed in the Analytical Summary Table.

METHODOLOGY/DISCUSSION

Volatile Organics - Volatile organics were analyzed according to EPA Method 524.2 Revision 3. The instrumentation used was a Tekmar Dynamic Headspace Concentrator interfaced with a Hewlett-Packard Model 5972A GC/MS/DS.

Due to high target compound concentrations, sample REP-1 and RW-12I were analyzed at a 1:10 dilution.

RESULTS

The results are presented in the following Tables. Also enclosed is all relevant data.

TABLE VO-1.0
3095-1016
GERAGHTY & MILLER
MISCELLANEOUS VOLATILE ORGANICS

Aqueous

All values are ug/L.

Client Sample I.D.	Method Blank	RW-12D	EB 072795	Quant. Limits with no Dilution
Lab Sample I.D.	VBLKEK	1016002	1016004	
Method Blank I.D.	VBLKEK	VBLKEK	VBLKEK	
Dilution Factor	1.00	1.00	1.00	
Chloromethane	U	U	U	1.0
Bromomethane	U	U	U	1.0
Vinyl Chloride	U	12	U	1.0
Chloroethane	U	U	U	1.0
Acetone	U	U	U	5.0
Methylene Chloride	U	~~48J~~ U	.57J	2.0
Carbon Disulfide	U	U	U	1.0
1,1-Dichloroethene	U	U	U	1.0
1,1-Dichloroethane	U	U	U	1.0
Trans-1,2-Dichloroethylene	U	U	U	1.0
cis-1,2-Dichloroethylene	U	2.9	U	1.0
Chloroform	U	~~1.5J~~ U	1.9	1.0
1,2-Dichloroethane	U	~~.93J~~ U	1	1.0
2-Butanone	U	U	U	5.0
1,1,1-Trichloroethane	U	U	U	1.0
Carbon Tetrachloride	U	U	U	1.0
Bromodichloromethane	U	U	U	1.0
1,2-Dichloropropane	U	U	U	1.0
Cis-1,3-Dichloropropene	U	U	U	1.0
Trichloroethene	U	1.1	U	1.0
Dibromochloromethane	U	U	U	1.0
1,1,2-Trichloroethane	U	U	U	1.0
Benzene	U	1	U	1.0
Trans-1,3-Dichloropropene	U	U	U	1.0
Bromoform	U	U	U	1.0
4-Methyl-2-Pentanone	U	U	U	5.0
2-Hexanone	U	U	U	5.0
Tetrachloroethene	U	3	U	1.0
1,1,2,2-Tetrachloroethane	U	U	U	1.0
Toluene	U	U	U	1.0
Chlorobenzene	U	.47J	U	1.0
Ethylbenzene	U	U	U	1.0
Styrene	U	U	U	1.0
Xylene (total)	U	U	U	1.0
2-Chloroethylvinylether	U	~~U~~ R	~~U~~ R	1.0
Dichlorodifluoromethane	U	U	U	1.0
Trichlorofluoromethane	U	U	U	1.0
Date Received		07/28/95	07/28/95	
Date Extracted	N/A	N/A	N/A	
Date Analyzed	08/07/95	08/07/95	08/08/95	

See Appendix for qualifier definitions
Note: Compound detection limit = quantitation limit x dilution factor

25

TABLE VO-1.1 Aqueous
3095-1016
GERAGHTY & MILLER
MISCELLANEOUS VOLATILE ORGANICS

All values are ug/L.

Client Sample I.D.	TB 072795	PK 10D		Quant. Limits with no Dilution
Lab Sample I.D.	1016005	1016006		
Method Blank I.D.	VBLKEK	VBLKEK		
Dilution Factor	1.00	1.00		
Chloromethane	U	U		1.0
Bromomethane	U	U		1.0
Vinyl Chloride	U	U		1.0
Chloroethane	U	U		1.0
Acetone	U	U		5.0
Methylene Chloride	U	U		2.0
Carbon Disulfide	U	U		1.0
1,1-Dichloroethene	U	U		1.0
1,1-Dichloroethane	U	.37J		1.0
Trans-1,2-Dichloroethylene	U	U		1.0
cis-1,2-Dichloroethylene	U	.39J		1.0
Chloroform	U	~~.23J~~ U		1.0
1,2-Dichloroethane	U	U		1.0
2-Butanone	U	U		5.0
1,1,1-Trichloroethane	U	U		1.0
Carbon Tetrachloride	U	U		1.0
Bromodichloromethane	U	U		1.0
1,2-Dichloropropane	U	U		1.0
Cis-1,3-Dichloropropene	U	U		1.0
Trichloroethene	U	U		1.0
Dibromochloromethane	U	U		1.0
1,1,2-Trichloroethane	U	U		1.0
Benzene	U	U		1.0
Trans-1,3-Dichloropropene	U	U		1.0
Bromoform	U	U		1.0
4-Methyl-2-Pentanone	U	U		5.0
2-Hexanone	U	U		5.0
Tetrachloroethene	U	.25J		1.0
1,1,2,2-Tetrachloroethane	U	U		1.0
Toluene	U	U		1.0
Chlorobenzene	U	U		1.0
Ethylbenzene	U	U		1.0
Styrene	U	U		1.0
Xylene (total)	U	U		1.0
2-Chloroethylvinylether	~~U~~ R	~~U~~ R		1.0
Dichlorodifluoromethane	U	U		1.0
Trichlorofluoromethane	U	U		1.0
Date Received	07/28/95	07/29/95		
Date Extracted	N/A	N/A		
Date Analyzed	08/08/95	08/08/95		

See Appendix for qualifier definitions
Note: Compound detection limit = quantitation limit x dilution factor

TABLE VO-1.2 Aqueous
3095-1016
GERAGHTY & MILLER
MISCELLANEOUS VOLATILE ORGANICS

All values are ug/L.

Client Sample I.D.	Method Blank	RW-12I	REP-1	Quant. Limits with no Dilution
Lab Sample I.D.	VBLKEM	1016001	1016003	
Method Blank I.D.	VBLKEM	VBLKEM	VBLKEM	
Dilution Factor	1.00	10.0	10.0	
Chloromethane	U	U	U	1.0
Bromomethane	U	U	U	1.0
Vinyl Chloride	U	U	U	1.0
Chloroethane	U	U	U	1.0
Acetone	U	U	U	5.0
Methylene Chloride	U	U	U	2.0
Carbon Disulfide	U	U	U	1.0
1,1-Dichloroethene	U	31	28	1.0
1,1-Dichloroethane	U	14	13	1.0
Trans-1,2-Dichloroethylene	U	U	U	1.0
cis-1,2-Dichloroethylene	U	6J	U	1.0
Chloroform	U	22 U	17 U	1.0
1,2-Dichloroethane	U	U	U	1.0
2-Butanone	U	U	U	5.0
1,1,1-Trichloroethane	U	64	56	1.0
Carbon Tetrachloride	U	U	U	1.0
Bromodichloromethane	U	3J	U	1.0
1,2-Dichloropropane	U	U	U	1.0
Cis-1,3-Dichloropropene	U	U	U	1.0
Trichloroethene	U	7.1J	6J	1.0
Dibromochloromethane	U	U	U	1.0
1,1,2-Trichloroethane	U	U	U	1.0
Benzene	U	U	U	1.0
Trans-1,3-Dichloropropene	U	U	U	1.0
Bromoform	U	U	U	1.0
4-Methyl-2-Pentanone	U	U	U	5.0
2-Hexanone	U	U	U	5.0
Tetrachloroethene	U	150	140	1.0
1,1,2,2-Tetrachloroethane	U	U	U	1.0
Toluene	U	U	U	1.0
Chlorobenzene	U	U	U	1.0
Ethylbenzene	U	U	U	1.0
Styrene	U	U	U	1.0
Xylene (total)	U	U	U	1.0
2-Chloroethylvinylether	U	~~U~~ R	~~U~~ R	1.0
Dichlorodifluoromethane	U	U	U	1.0
Trichlorofluoromethane	U	U	U	1.0
Date Received		07/28/95	07/28/95	
Date Extracted	N/A	N/A	N/A	
Date Analyzed	08/09/95	08/09/95	08/09/95	

See Appendix for qualifier definitions
Note: Compound detection limit = quantitation limit x dilution factor 4

TABLE VO-1.3
3095-1016
GERAGHTY & MILLER
MISCELLANEOUS VOLATILE ORGANICS

Aqueous

All values are ug/L.

Client Sample I.D.	PK 10I	PK 10S	SY-8	Quant. Limits with no Dilution
Lab Sample I.D.	1016007	1016008	1016009	
Method Blank I.D.	VBLKEM	VBLKEM	VBLKEM	
Dilution Factor	1.00	1.00	1.00	
Chloromethane	U	U	U	1.0
Bromomethane	U	U	U	1.0
Vinyl Chloride	U	U	U	1.0
Chloroethane	U	U	U	1.0
Acetone	U	U	U	5.0
Methylene Chloride	U	U	U	2.0
Carbon Disulfide	U	U	U	1.0
1,1-Dichloroethene	U	U	U	1.0
1,1-Dichloroethane	4.5	3.2	.87J	1.0
Trans-1,2-Dichloroethylene	U	U	U	1.0
cis-1,2-Dichloroethylene	2.2	U	U	1.0
Chloroform	U	U	U	1.0
1,2-Dichloroethane	U	U	U	1.0
2-Butanone	U	U	U	5.0
1,1,1-Trichloroethane	U	1.8	U	1.0
Carbon Tetrachloride	U	U	U	1.0
Bromodichloromethane	U	U	U	1.0
1,2-Dichloropropane	U	U	U	1.0
Cis-1,3-Dichloropropene	U	U	U	1.0
Trichloroethene	1	U	.97	1.0
Dibromochloromethane	U	U	U	1.0
1,1,2-Trichloroethane	U	U	U	1.0
Benzene	.34J	U	U	1.0
Trans-1,3-Dichloropropene	U	U	U	1.0
Bromoform	U	U	U	1.0
4-Methyl-2-Pentanone	U	U	U	5.0
2-Hexanone	U	U	U	5.0
Tetrachloroethene	3.1	1.1	17	1.0
1,1,2,2-Tetrachloroethane	U	U	U	1.0
Toluene	U	U	U	1.0
Chlorobenzene	20	U	U	1.0
Ethylbenzene	U	U	U	1.0
Styrene	U	U	U	1.0
Xylene (total)	U	U	U	1.0
2-Chloroethylvinylether	~~U~~ R	~~U~~ R	~~U~~ R	1.0
Dichlorodifluoromethane	U	U	U	1.0
Trichlorofluoromethane	U	U	U	1.0
Date Received	07/29/95	07/29/95	07/29/95	
Date Extracted	N/A	N/A	N/A	
Date Analyzed	08/09/95	08/09/95	08/09/95	

See Appendix for qualifier definitions
Note: Compound detection limit = quantitation limit x dilution factor

EB

TABLE VO-1.4
3095-1016
GERAGHTY & MILLER
MISCELLANEOUS VOLATILE ORGANICS

Aqueous

All values are ug/L.

Client Sample I.D.	SY-3D	EB 072895	TB 072895	Quant. Limits with no Dilution
Lab Sample I.D.	1016010	1016011	1016012	
Method Blank I.D.	VBLKEM	VBLKEM	VBLKEM	
Dilution Factor	1.00	1.00	1.00	
Chloromethane	U	U	U	1.0
Bromomethane	U	U	U	1.0
Vinyl Chloride	U	U	U	1.0
Chloroethane	U	U	U	1.0
Acetone	U	U	U	5.0
Methylene Chloride	U	.42J	.22J	2.0
Carbon Disulfide	U	U	U	1.0
1,1-Dichloroethene	U J	U	U	1.0
1,1-Dichloroethane	.91J	U	U	1.0
Trans-1,2-Dichloroethylene	U	U	U	1.0
cis-1,2-Dichloroethylene	U	U	U	1.0
Chloroform	U	1.9	.86J	1.0
1,2-Dichloroethane	U	U	U	1.0
2-Butanone	U	U	U	5.0
1,1,1-Trichloroethane	U	U	U	1.0
Carbon Tetrachloride	U	U	U	1.0
Bromodichloromethane	U	U	U	1.0
1,2-Dichloropropane	U	U	U	1.0
Cis-1,3-Dichloropropene	U	U	U	1.0
Trichloroethene	U	U	U	1.0
Dibromochloromethane	U	U	U	1.0
1,1,2-Trichloroethane	U	U	U	1.0
Benzene	1.4	U	U	1.0
Trans-1,3-Dichloropropene	U	U	U	1.0
Bromoform	U	U	U	1.0
4-Methyl-2-Pentanone	U	U	U	5.0
2-Hexanone	U	U	U	5.0
Tetrachloroethene	U	U	U	1.0
1,1,2,2-Tetrachloroethane	U	U	U	1.0
Toluene	U	U	U	1.0
Chlorobenzene	5.1	U	U	1.0
Ethylbenzene	U	U	U	1.0
Styrene	U	U	U	1.0
Xylene (total)	U	U	U	1.0
2-Chloroethylvinylether	~~U~~ R	~~U~~ R	~~U~~ R	1.0
Dichlorodifluoromethane	U	U	U	1.0
Trichlorofluoromethane	U	U	U	1.0
Date Received	07/29/95	07/29/95	07/29/95	
Date Extracted	N/A	N/A	N/A	
Date Analyzed	08/09/95	08/09/95	08/09/95	

See Appendix for qualifier definitions
Note: Compound detection limit = quantitation limit x dilution factor

ORGANICS APPENDIX

U - Indicates that the compound was analyzed for but not detected.

J - Indicates that the compound was analyzed for and determined to be present in the sample. The mass spectrum of the compound meets the identification criteria of the method. The concentration listed is an estimated value, which is less than the specified minimum detection limit but is greater than zero.

B - This flag is used when the analyte is found in the blanks as well as the sample. It indicates possible sample contamination and warns the data user to use caution when applying the results of this analyte.

N - Indicates that the compound was analyzed for but not requested as an analyte. Value will not be listed on tabular result sheet.

S - Estimated due to surrogate outliers.

X - Matrix spike compound.

(1) - Cannot be separated.

(2) - Decomposes to azobenzene. Measured and calibrated as azobenzene.

A - This flag indicates that a TIC is a suspected aldol condensation product.

E - Indicates that it exceeds calibration curve range.

D - This flag identifies all compounds identified in an analysis at a secondary dilution factor.

C - Confirmed by GC/MS.

T - Compound present in TCLP blank.

P - This flag is used for a pesticide/aroclor target analyte when there is a greater than 25 percent difference for detected concentrations between the two GC columns (see Form X).